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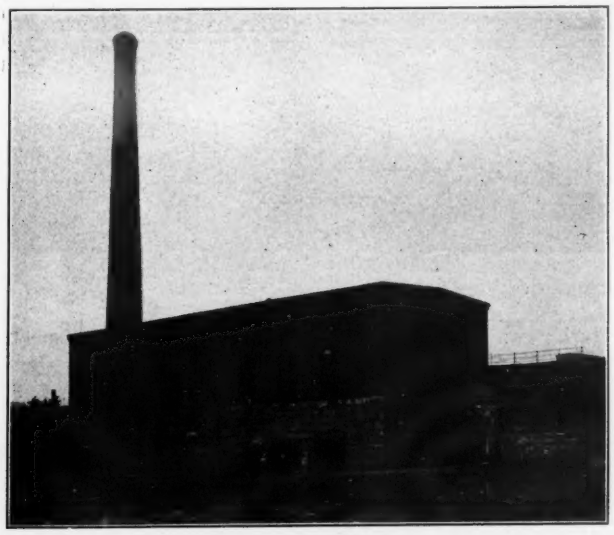
THE NEW HOLYOKE HYDRO-ELECTRIC POWER PLANT

A Water Power Plant with Steam Turbine Auxiliary Equipment

BY FRANK C. PERKINS.

One of the latest and most thoroughly up-to-date hydro-electric power developments in Massachusetts is that of the Holyoke Water Power Co., recently completed on the right bank of the Connecticut River. The Connecticut River above the dam drains an area of 8,000 square miles and the ordinary flow of the river is more than 10,000 cubic feet of water per second, with a total possible hydraulic development of 75,000 horse power.

The new power house of the Holyoke Water Power Co. is constructed of brick and steel, being located on the west bank of the Connecticut River, at the lower end of East Dwight Street, in Holyoke. It has a total length of over 160 feet, and is 60 feet wide, being two stories in height.



River View of Holyoke Plant showing Spillway, Tailraces and Condenser

There are two twin water-wheels in this plant, each having an output of 1,000 horse power and directly-connected to three-phase alternators of 600 kilowatts each. These electrical generators supply current at 2,300 volts and have their field coils excited by a small water motor driven exciter of 50 kilowatt capacity, supplying continuous current of 125 volts. Provision has been made for a third pair of water-wheels, also of 1,000 horse power capacity, when it is found necessary to increase the output of the station.

New Stone Dam with 3 ft. of Water on Crest at Holyoke, Mass.

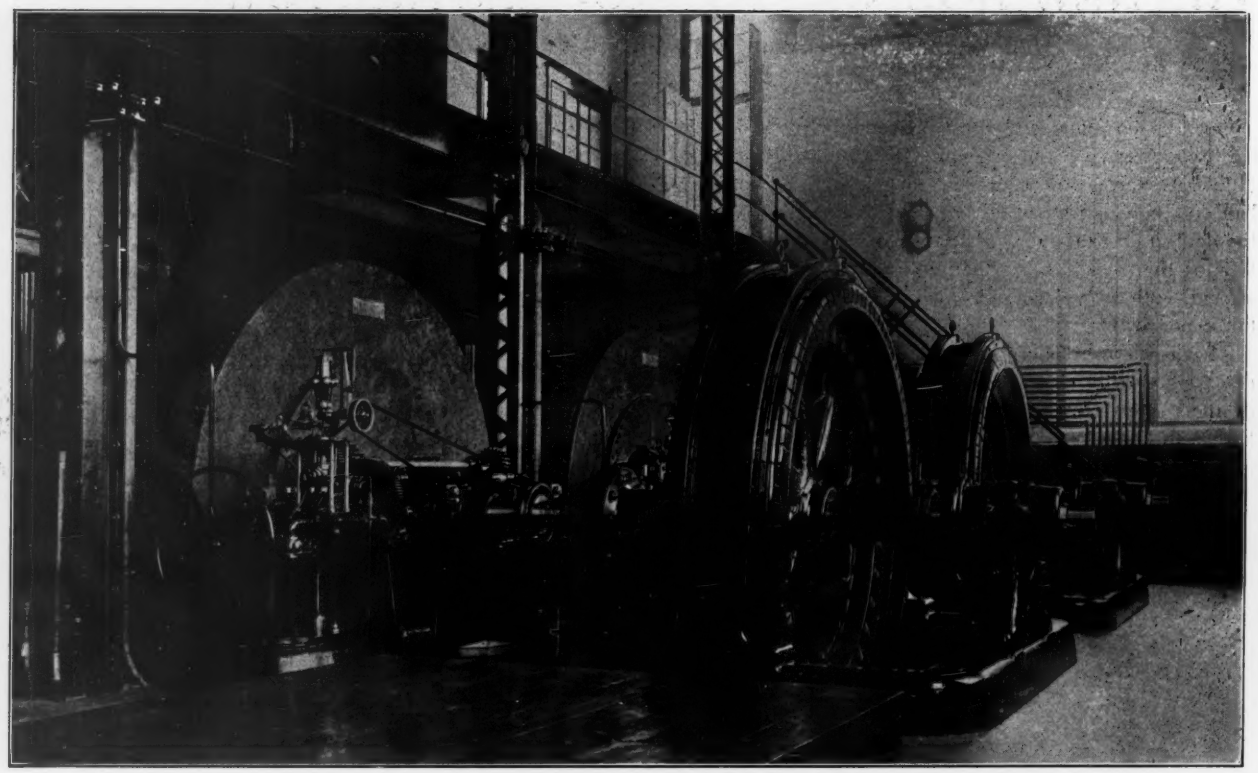
The canal extension is 10 feet deep and 80 feet wide at the bottom, with a width of 120 feet at the line of the full canal. There are four penstocks connecting the power plant with the head gates at the terminus of the canal, three of which are 11 feet in diameter, and the remaining one 3 feet in diameter, the latter supplying water to the exciter unit, and two of the large penstocks supplying water to the large alternator units. These penstocks are 75 feet in length and connect with the water-wheel cases, which are 30 feet long and 13 feet in diameter. In these water-wheel cases are located two McCormick wheels of 42 inches, which discharge into raceways through draught tubes, the water being carried to the river. The ordinary river level at this place gives a fall of 33 feet. There is an overflow provided at the terminus of the canal in addition to the head gates, constructed of granite masonry with four wicket gates 4 x 4 feet, the spillway being 75 feet in length. There are removable flashboards provided 3 feet in depth, and the capacity of the spillway is about 4,000 horse power, or 60 mill

powers, each of these being considered at Holyoke the same as about 65 horse power.

At the power house steam turbines are also utilized and a 16-inch cast-iron main is utilized between the power house and the canal for providing condensing water as well as feed water for the boilers.

Each penstock is provided with a 20-inch cast-iron vent pipe to break up any pocket of air. Special provisions have been made to take care of the slush ice in winter, and it is maintained that there will be no difficulty arising from this cause during the coming winter, as arrangements have been made to shunt the ice into the river through the spillway, thereby avoiding any clogging arising from this source.

Steam turbine units as well as gas engine units are now being extensively employed in America as auxiliary equipment for hydro-electric power stations. These steam turbine driven or gas engine driven electric generators are frequently employed for taking care of the peak of the load and also acting as a reserve in case of low water or in times of accident to the hydraulic turbines or other emergency.



1000 Horse Power Water Wheels connected to Three-Phase Alternators in the Plant of the Holyoke Water Power Co.

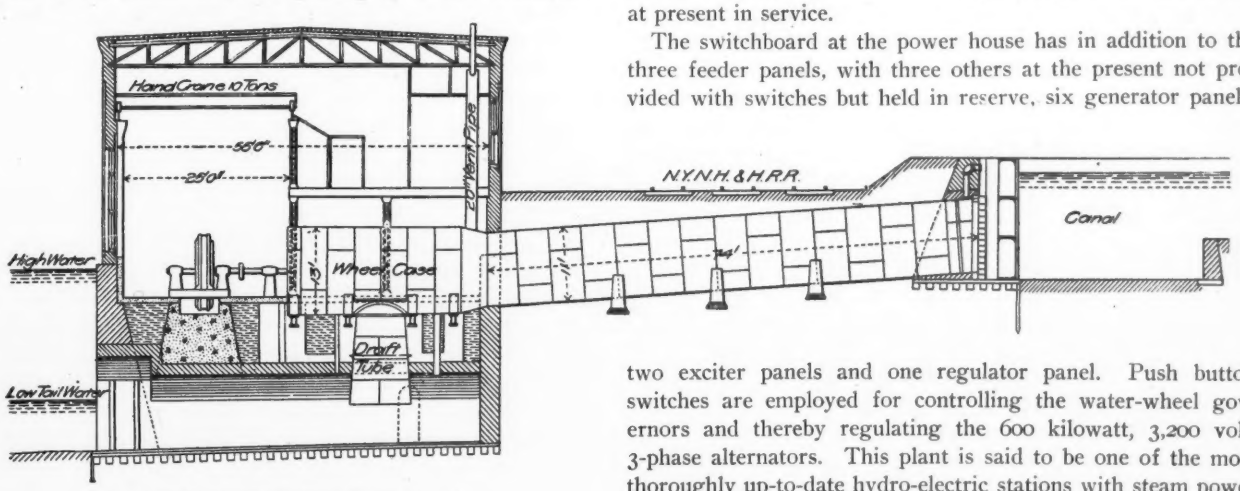
At the Holyoke power station the western part of the building is occupied by a boiler room and steam turbine room, the former being at present equipped with three vertical boilers of the Manning type with space provided for a duplicate equipment, when found necessary. These vertical boilers each have a capacity of 200 horse power and were constructed by the Holyoke Steam Boiler Works. Bituminous coal is utilized at about 4 dollars per ton and plain End fired rocking grates are utilized, the fuel being brought from a storage pit of 2,500 tons capacity by means of narrow gauge charging cars from which the coal is thrown directly into the furnace. The boilers are connected with a radial brick stack with 7-foot flue and a total height of 175 feet.

The boilers are connected with the city water works main as well as a condenser hot well and the two feed pumps installed are also arranged to deliver water from the canal or river, if desired. There is a duplicate system of steam piping provided with a main header feeding the necessary steam to the turbines and an auxiliary header from which the exciter, the steam turbine, the auxiliary apparatus and pump take steam. An extra heavy steel pipe 14 inches in diameter is employed as a main header with branches 6 inches in diameter, while the auxiliary main has two boiler branches and is itself 5 inches in diameter. At the present time there is only one branch from the main header, as only one steam turbine has been installed, although provision has been made for two other steam turbo-alternator units of 500 kilowatts each. When the three steam turbines are installed with the complete boiler equipment the steam generating installation will have a capacity of 1,500 kilowatts.

The new 500 kilowatt turbine at present installed is connected by a 7-inch branch to the main header, while the steam turbine exciter unit is connected with the auxiliary main by a 3-inch branch pipe. The steam turbo-alternator was constructed by the General Electric Company and is of the Curtis vertical type, operating at a speed of 1,800 revolutions per minute. It is provided with a mechanical governing mechanism and is designed to stand an overload of 50 per cent. This 500 kilowatt turbine unit exhausts into a Bulklay barometric condenser of 1,000 horse power capacity, located just outside the station. The turbine is connected to this condenser by a pipe 16 inches in diameter. An atmospheric relief valve is pro-

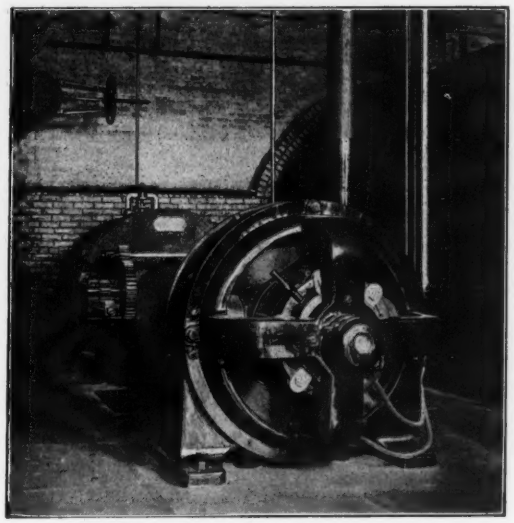
vided at the top of the exhaust riser, provision being made to exhaust freely to the atmosphere in case of trouble with the condenser.

The 500 kilowatt General Electric alternator is connected with the switchboard by cables placed in iron conduits embedded in the cement floor and passing up to the switchboard



Holyoke Hydro-Electric Plant

gallery through the iron column supporting the same, the turbo-alternator cables being No. 000 paper insulated, No. 00 wire being employed for the field coil connections. A separate conduit is provided for the field coil wires and for the conductors of a small motor on the governors of the McCormick wheels. There are 3-inch conduits provided for the conductors to the feeder switches, rubber covered cables using No. 000 single conductors being employed.



50 K. W. Water Turbine Driven Exciter

One of the main feeder lines connects the Holyoke power station with the Municipal plant switchboard in order to provide auxiliary power during heavy load to the Municipal Lighting station. Another feeder circuit connects the power station with a paper mill in South Hadley, a distance of about four miles from the Holyoke plant. The current is raised in pressure to 6,600 volts for use on this power transmission line by means of three step-up transformers of the oil cooled type, each having a capacity of 75 kilowatts. The current is utilized for operating induction motors in the paper mill. Another feeder line has been constructed, connected to the switchboard of the Holyoke Water Power Company's plant, but this is not at present in service.

The switchboard at the power house has in addition to the three feeder panels, with three others at the present not provided with switches but held in reserve, six generator panels, two exciter panels and one regulator panel. Push button switches are employed for controlling the water-wheel governors and thereby regulating the 600 kilowatt, 3,200 volt, 3-phase alternators. This plant is said to be one of the most thoroughly up-to-date hydro-electric stations with steam power auxiliary equipment in the Eastern States.

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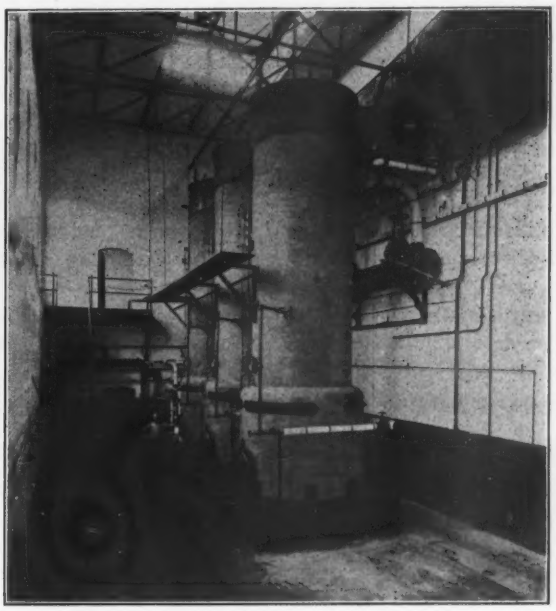
The two vital features in the design of a steel stack consist in the determination of the strength of the anchor bolts and the stability of the base. A stack may either break off at any section, overturn about the cast-iron base, to which the anchor bolts are secured, or the stack may overturn about the footings.



Boiler Room of the Holyoke Hydro-Electric Plant

The stress on the anchor bolts depends upon the diameter, height and general form of stack and the diameter of the base, so that the resisting moment of the bolts and base must at least be greater than the overturning pressure due to a maximum wind pressure of 40 pounds per square foot.

Care and Management of Horizontal Tubular Boilers

Practical Points about Shutting Down, Cleaning and Starting Up

By Wm. Kavanagh.

The proper care and management of the horizontal tubular steam boiler is of the utmost importance in order that we may obtain the highest economical conditions that the boiler is capable of developing. If we permit the tubes and shell to become coated with ashes or soot or dirt of any kind, those conditions will not be realized. The heating surface of all the tubes in a horizontal tubular boiler is many times as great as the heating surface of the shell; hence it follows that the tubes should be kept clean.

In order that the large difference between the heating surface of the shell and that of the tubes be better understood, the following example is given: Suppose a boiler has a diameter of 5½ feet and length 16 feet, having 90 three-inch tubes, the heating surface is found as follows: The diameter of the boiler is 66 inches, and $66 \times 3.1416 = 207.345$ inches, which equals the circumference of the shell in inches. Now, the length is 192 inches, so that $207.345 \times 192 = 39810.24$ square inches, or 276.4 square feet, and since two-thirds of that amount is available for heating surface, this gives $^2/_3 \times 276.4$, or 184.3 square feet of heating surface in the shell.

To get the heating surface of the tubes, find the area of one tube and multiply this surface by the number of tubes. In the above problem, the heating surface of all the tubes is 745.2 square feet, from which it can be seen that the heating surface of the tubes is over four times as great as the heating surface of the shell.

This illustration serves to impress the fact that the tubes contain the greatest amount of heating surface and it is therefore necessary to keep all the tubes free from non-conductors of heat. Of course, it is understood that all the heating surface of a boiler should be kept clean.

In order to clean out a boiler, it should not be blown down the night before cleaning, but the water should be allowed to remain in the boiler until the time of opening. Then the safety valve should be raised, the blow-off valve opened and the water allowed to run out by gravity. In many cases this cannot be done, owing to the peculiar way in which the blow-off may be connected, or the fact that there may be but one boiler in the plant; under such conditions, we must do the best thing possible.

Some engineers blow down their boilers on Saturday night and on Sunday open the boiler for cleaning. This is poor policy as the brick-work around the boiler is hot and after the water is all blown out, the heat from the brick-work rapidly dries the metal and nearly all the scale and sediment will be found to adhere tenaciously to the shell and tubes, thereby causing extra labor to remove the scale. If the water is allowed to remain in the boiler over night, a great portion of the scale will be deposited on the crown sheet, thus facilitating its removal.

It might be argued that if this plan is followed, the boiler will be too hot for cleaning, but this can be prevented to a large extent by leaving the doors and damper open during the night and by cleaning out as late as possible the next afternoon. It is not necessary to take out all the manhole and handhole plates every time we wish to clean. Good results will be obtained by taking out the front handhole or manhole plate and removing the scale from the back with a long hoe, washing the entire boiler out with a hose. This method could be followed with good results, provided it is done about twice each month. A great deal depends upon the kind of water being used and the method of feeding the boiler. If the water is impregnated with lime, magnesia, etc., the boiler may have to be cleaned out oftener than twice each month.

When a boiler is to be washed out and time will permit, the following method will be found to be the correct one: When the boiler is shut down, close all draughts and allow the boiler to cool in unison with the surrounding brick-work. This will take from two to four days, depending in a great measure upon the amount of water that the boiler contains and also upon the size of the boiler. By doing this, the water will disintegrate the scale and a large amount of it will be deposited on the bottom. After the water is run out of the boiler, the manhole and handhole plates should be taken off and a strong stream of water should be played between the tubes and around the shell and heads. *Don't attempt to place a lighted candle or lamp in the boiler until after the boiler is partly washed out.* If any boiler compound or kerosene oil is used as a scale preventer, an explosion may occur if the light is first placed in the boiler. This same precaution should be taken when washing out a feed-water heater.

After the boiler is washed out, it can be entered for inspection and all the braces and stays should be carefully tested. It is important to have a lamp placed beneath the tubes; then, while inside of the boiler, any scale which may be lodged between the tubes can be readily seen. A very convenient way to dislodge any scale found between the tubes is to swing a flat bar of iron longitudinally between them and in this way all the scale can be removed.

In washing out a horizontal tubular boiler, it will be found good practice to insert a wooden plug in the blow-off opening of the shell, as this will prevent the pipe from becoming stopped with scale. By taking this precaution, considerable labor will probably be saved, as considerable trouble is often encountered from scale finding its way into the blow-off. While the boiler is open, the brass plugs, if any, in the water column connection should be removed and the connections inspected for scale.

In closing up the boiler, all manhole and handhole plates should be scraped clean and that portion of the head against which the gaskets are pressed should also be cleaned; if this is properly done, no difficulty will be experienced from leaky handhole or manhole plates.

Before closing the boiler, take out the wooden plug and close the blow-off valve, being sure that there is no scale beneath the disc. Now pour into the boiler about five gallons of kerosene and after the boiler is entirely closed, allow water to flow into the boiler very slowly. The slower the boiler is filled, the more opportunity will the kerosene have to attack the scale and corrosion in the boiler. After the boiler has been

filled a little above the usual height, open the blow-off and permit the water to slowly run out. By doing this, a double opportunity is given to the kerosene oil to attack the scale and corrosion.

When starting up a boiler, it should be filled with hot water, if possible, and after locating the proper level of water, the fire should be started slowly. Particular attention should be given to this, especially if the water in the boiler is cold, as enormous strains may occur through unequal expansion. In many cases, leaks have occurred by starting fires too suddenly and this practice will, sooner or later, lead to the destruction of the boiler.

If the boiler is to be laid up for some time, the shell and heads should be painted with red lead and oil. This will prevent to a large extent any dampness from attacking the iron and starting corrosion.

ANSWERS TO ENGINEERS' QUESTIONS

Efficiency of Boiler, Practical Indicator Cards, Area of Grate and Safety Valve Problems

By C. J. Mason.

The following are the answers to some of the questions asked by F. L., of Chicago, Ill., on page 26 of the August issue of The Practical Engineer, which may be of interest to your readers:

Question 1.—At a boiler test it was found that 11,000 British thermal units were used to evaporate 7 pounds of water. What is the efficiency of the boiler and explain how you find it?

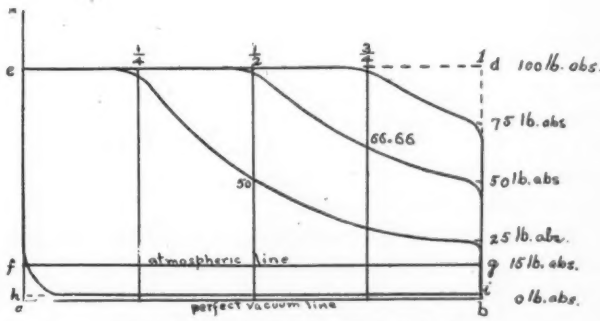
Answer.—In this question, 7 pounds of water have been evaporated at an expense of 11,000 British thermal units. Since it requires 966.1 British thermal units to convert 1 pound of water at 212 degrees Fahr. into steam at 212 degrees, to convert 7 pounds of water into steam at 212 degrees Fahr. will require $7 \times 966.1 = 6762.7$ British thermal units, from which the efficiency is obtained by dividing 6,762.7 by 11,000, which equals 61.48 per cent.

Or, we may take it like this: Every 966.1 British thermal units represent one pound of water evaporated, and as there were 11,000 British thermal units expended in evaporating the water, if all the heat was utilized, there should have been $11{,}000 \div 966.1 = 11.38$ pounds of water evaporated. But since there were only 7 pounds evaporated, then 7 divided by 11.38 gives 61.48 per cent., which is the same answer as obtained above.

Question 2.—Make practical diagrams of a condensing engine, 85 pounds boiler pressure, 26-inches vacuum with cut-off ¼, ½ and ¾ stroke.

Answer.—The accompanying diagram answers question No. 2. The manner in which the diagram was drawn is as follows: First of all it was decided to make the diagram four inches in length, because that is a convenient figure to work with in relation to the points of cut-off with which we are dealing. Next it was decided to draw the diagram to a vertical scale of 50 pounds to the inch, because that scale will give a symmetrical figure when considering the chosen length. Draw the line *ab,* four inches in length, and let it represent the line of zero pressure, or the perfect vacuum line. At point *a* erect a vertical line *ac* at right angles, or square, as we say, to the line *ab.* At a height corresponding to 85 pounds gauge pressure or 100 pounds absolute pressure, draw the line *ed.* Using the scale of 50, this makes the diagram 2 inches high from the line of zero pressure. As a matter of convenience, the pressure of the atmosphere has been assumed to be 15 pounds per square inch instead of 14.7, the correct value, so that 85 pounds gauge plus 15 pounds per square inch equal 100 pounds absolute pressure.

Draw the atmospheric line *fg* next, to the same scale of 50; this will make it come $^3/_{10}$ of an inch above the line *ab.* Next draw the back pressure line *hi* at a distance corresponding to 26 inches of vacuum from the atmospheric line or at a distance corresponding to 2 pounds absolute from the perfect vacuum line *ab,* using the same scale of 50. Divide the diagram into four equal parts, so that each vertical line will represent the points of cut-off, respectively, named in the question. On the line *bd* lay off the points which are to represent the terminal pressure, due to the three points of cut-off referred to. These pressures are to be measured off on the line of perfect vacuum in pounds absolute, to the scale of 50, the terminal pressure being found like this: For ¼ cut-off, 100 pounds absolute pressure, $\frac{1}{4} \times 100 = 25$ pounds absolute terminal pressure; ½ cut-off, 100 pounds absolute pressure, $\frac{1}{2} \times 100 = 50$ pounds absolute terminal pressure and for ¾ cut-off, $\frac{3}{4} \times 100 = 75$ pounds absolute terminal pressure.



Method for Constructing Theoretical Cards

After these points, 25 pounds, 50 pounds and 75 pounds absolute are located on the line *bd,* as shown in the diagram, draw the expansion lines by using a curve, or a thin steel scale, such as machinists and engineers use, which can be bent to conform to the curve illustrated. While the curves so drawn may not be exactly correct in form, they will be sufficiently close for the purpose required. The three diagrams are here drawn on the same figure as a matter of convenience, but each may be drawn separately if desired.

Question 3.—What area of grate would you put under a boiler 72 inches diameter, 20 feet long, flues of the ordinary size and number?

Answer.—In answer to question No. 3, a 72-inch boiler should have a grate at least 5 feet wide and 6 feet in length. This makes $6 \times 5 = 30$ square feet of grate surface. There

are two or three ways that grate area may be found, one of which is given in the August, 1906, issue of THE PRACTICAL ENGINEER, at the top of page 30. Another way is to take a certain ratio between the heating surface and grate surface. Generally speaking, and in any given question where no data is given, it is fair to assume that the width of the grate will nearly equal the diameter of the boiler and 6 feet is considered as the maximum desired length. In this question, when using the different methods, the grate area may vary from 25 to 36 square feet.

Question 4.—What size safety valve would you put on a tubular boiler?

Answer.—There are several ways to figure the size of a safety valve to place on a boiler, the results of which vary. Probably one rule that is as good as any in existence, is that of the Bureau of Steam Engine and Steam Boiler Inspection of Philadelphia, and the Hartford Steam Boiler Inspection and Insurance Company. The rule is stated thus:

$$A = \frac{22.5\ G}{P + 8.62} \text{ for natural draft}$$

$$A = \frac{1.406\ W}{P + 8.62} \text{ for forced draft}$$

in which

G = grate surface in square feet.
P = steam pressure by gauge.
W = weight in pounds of coal burned per hour.
A = area of safety valve in inches.

After the area of the valve is found from the foregoing formulas, the diameter may be found by dividing the area by .7854 and extracting the square root of the quotient.

Question 5.—What is the maximum lift of a safety valve?

Answer.—With regard to the maximum lift of a given safety valve, I would say that when a valve lifts to such an extent that the area of opening at the circumference equals the area of the valve itself, any further lift would not permit more steam to escape; so that when the areas referred to are equal, the maximum effective lift has been reached. This lift is found by calculation to be ¼ of the diameter of the valve; that is, a 4-inch safety valve will have a maximum lift of one inch, the area of a four-inch valve being 12.56 square inches and the area of the opening at the circumference of the valve = 1″ (¼ diameter of 4-inch valve) multiplied by the circumference of a 4-inch valve, which equals $4 \times 3.1416 = 12.56$ inches and $12.56 \times 1 = 12.56$ square inches area; so that one inch lift is the maximum required. For any other size valve, ¼ the diameter will give absolutely the same result.

Question 6.—At what pressure would you set the safety valve of your boiler?

Answer.—Concerning question No. 6, first find the bursting pressure of the given boiler by this rule:

"Multiply the thickness of the shell plates in inches by the tensile strength of the plates in pounds per square inch and that product by the percentage of strength of the joint; then divide that product by the radius of boiler in inches." In formula, it appears like this:

$$\frac{T \times S \times \text{per cent. } S}{r} = \text{Bursting pressure in pounds per square inch.}$$

in which

T = thickness of plate in inches.
S = tensile strength of plate in pounds.
per cent. S = percentage of strength of joints, compared with the solid plate.
r = radius of boiler in inches.

It is usual in stationary practice to allow a factor of safety of 6 in boiler work, so that $^1/_6$ of the bursting pressure, as found by the foregoing rule, will be the pressure at which to set the safety valve.

What can be Learned from Ads. and Catalogues

BY JOHN C. SCOTT.

Some people object to subscribing for a craft journal if it contains more than a few pages of advertising matter, as they claim that they are paying for this advertising and it does them no good. Now, let's look into the matter a little and see if they are not mistaken when they say they pay for it, and we will also find that the average advertisement, carefully read and studied, will be a source of benefit.

Now, as to the paying for advertising matter placed in this or any other trade paper, this is always done by the advertiser. Some think, however, that when they subscribe for the paper they are compelled to subscribe for the advertising also—sort of a case of "take both or none." This far, they are right! But they continue to think further that if the advertisements were omitted, they ought to be able to get the paper for one-half or three-fourths its regular cost, as the expense of publishing the "ads" would disappear with the ads., and that this expense to the subscriber is in proportion to the amount of the space they occupy. Nothing could be farther from the truth. If an average paper has one-half of its pages filled with paid advertising matter, and it should decide to stop publishing any ads., thereby reducing the size of the sheet one-half—still publishing the same amount of reading matter—then the subscriber would have to pay possibly three times or over the former subscription price in order to get this same reading matter into his hands, but without any advertisements. So you see that the publishers, by accepting advertisements, are enabled to place their publication in the hands of the subscriber at greatly reduced rates and there is no compulsory clause to the subscription contract that you must read them.

The subscriber, by accepting the publication containing a liberal amount of advertising, gets his reading matter at greatly reduced rates as compared with what he would have to pay for the same without advertising matter "thrown in." It is co-operation between all parties concerned. It is on the same plan as a certain shoe manufacturer who is advertising his goods. He is going around painting the farmers' barns, granaries, or wagon sheds, all over, for the privilege of painting his ad. on the side next to the road.

Now as to the benefits to be derived from the average ad. carefully read and studied. I know a young man who secured

a first-class, unlimited Ohio license on information picked out of advertisements and catalogues which were brought from the office waste baskets and dumped on the floor of the boiler room where he was firing, so that he might burn them. Among them were circulars of different makes of engines, boilers, pumps, heaters, etc., each illustrating their own product and giving "skeleton" or "shadow" views of the inside construction; each also had certain "points of superiority not possessed by any other make." All these he carefully studied. He saw how braces were usually put in a boiler. He also noticed that in all styles and makes of boilers the hand and manholes were invariably made oval. He wondered why some of them, especially the small ones, were not made round. He kept on wondering until he studied it out.

He picked up an old stock list of a Steel & Iron Co. and found the U. S. Government Rules for testing tensile strength, etc. This same stock list also told him how to find the safe working pressure of a boiler; how to compute the horse power of a boiler, also of an engine; that doubling the diameter of a pipe increased its capacity four times; that the height in feet of a column of water multiplied by .434 equaled the pressure in pounds per square inch; that the evaporation of 30 pounds water per hour from 100 degrees F. into steam at 70 pounds gauge pressure equals one horse power; that the atmosphere exerted a pressure of 14.7 pounds at sea level *and that it decreased as we ascended above it;* that a cubic foot of water weighed 62.5 pounds; that it was heaviest at 39.2 degrees F. and about one hundred and fifty other questions likely to be asked when being examined, were answered in the above way.

Then it went on to explain the difference between punched and drilled holes; how rivets should be spaced; sheaving strength of rivets, etc. It also showed an approved plan of boiler setting. It illustrated the different kinds of boiler braces carried by this concern and gave the names of each kind. They listed and illustrated nearly every tool or machine used in boiler making, showing same in operation.

Then, one day, he picked up a folder from a rope transmission firm doing business in the Hoosier State and from it he learned that the horse power a belt will transmit is in direct proportion to its speed.

He came to the conclusion from this that if you have a 400 revolution per minute machine driven from a countershaft making 200 revolutions per minute and this countershaft was driven by a line shaft making 200 revolutions per minute, that the belt from the machine to countershaft need be only one-half as wide as the belt from the countershaft to the line shaft; but that if the machinery and countershaft had the same revolutions per minute, then both belts should be the same width, the same as if the machine was belted direct from the line shaft.

One day, he was filling the lubricator, which was the ordinary single connection sight feed kind, and he got to wondering how the "blamed" thing worked. He knew that oil, being lighter than water, would stay on top, as it showed in the gauge glass when it was about half empty, but the oil coming up through the feed glass was apparently always coming from the bottom. The single connection arrangement also puzzled him till, one day, he was looking through the advertisements of an engineering paper and one firm advertising lubricators had a cut of one sawed "right through the middle" showing the inside arrangements of tubes; then it was as plain as day to him.

Another line of knowledge which nine out of every ten engineers must learn from catalogues, is the names of pipe fittings. I have never yet run across a text-book which would show you what a drop elbow, flange left or flange right, return bend, open or close coupling, drop tee, female, or male and female, street elbow, side outlet elbow or side outlet tee, was, and these are not half of the fittings met with in practice. Most engineers know the names of such fittings as elbows, tees, unions, etc. But if he is able to sit down and make out an order to a supply house for all the different gas and steam pipe fittings and knows how to describe in the regular way a certain fitting with certain openings of a certain size, I bet my next week's wages he has studied some supply house's catalogue, because that is the only way I know of where such information is printed and illustrated.

Now as to a steam gauge, none of my text-books explain how steam gauges work or even show how they are constructed, but by looking at the ad. of some manufacturer of gauges where he has inserted a cut showing the inside construction, we can see what is necessary in order to make the pointer move, hence we come to the conclusion that any increase in the pressure must have a tendency to straighten out the curved C shaped spring. We wonder why that loop is put in the pipe just below the steam gauge, where the gauge is connected above the water line, while those connected below the water line have a pipe with no loop in it. We go home that night and look through all our books, for which we paid from one to four dollars and fifty cents per volume, and each claimed to answer fully any and all questions which might arise, but they don't say a word about what that loop is there for, and we remain in the dark until the next Sunday morning when we are taking a walk past a certain engine room door and hear a familiar voice sing out: "Hello! there, old boy, come in!" We go in and find Smith, the engineer, there taking the old steam gauge off preparatory to putting on a new one. We ask Smith what is wrong with the old one. He says he does not know, but that it would not register anything near the correct pressure.

We took the new one out of the box and read the directions and they inform you never to connect a steam gauge direct to the steam without using a steam gauge syphon, as the heat of the steam entering the gauge would spoil the temper of any spring. Then we knew. So that by carefully studying advertisements we can see the construction of the many different styles of steam traps, safety water columns, pop valves and all other kinds of valves, feed water heaters, exhaust heads, exhaust mufflers, engines, pumps, boilers, injectors and every known appliance found in a complete steam plant. Each advertiser calling attention to the "points of superiority" of his product gives the engineer a chance to study these "points" and to weigh one against the other. He can study the construction of each different piece, the principle on which it works, and when he is called on to make a selection, he can do so intelligently, setting forth his reasons for liking best that particular injector, high or low water alarm, pump, or whatever other apparatus he must buy. Then, when the apparatus arrives, he does not have to tear it all apart in order to understand it. He understood it before he recommended its purchase, or at least, should have. Thanks to advertisements and illustrations.

SYSTEM IN FINDING THE COST OF POWER

Some Points about the Business End of Engineering

By D. C. Eggleston.

The fundamental principle in cost accounting is that the articles manufactured must cancel all expenses incurred in their production. That this may be accomplished, a system is required for finding the expense incurred in producing power. Such a system provides for making a detailed analysis of power expense items in the exhibit of shop expense and also facilitates practicing economies. That the work of collecting, recording and analyzing data may be as automatic as possible, an adequate system is required.

Power expense is one of the main divisions of shop or indirect expense. The aim is to find the cost per unit of the power generated or transmitted, which facilitates assessing various departments or groups of machines for power used. There are several kinds of power often used, so that cost system experts make provision for finding the cost per pound of steam, per kilowatt hour generated or transmitted and per 1,000 cubic feet of free air compressed. That the desired results may be obtained, it is necessary to classify all accounts. Reference to the detailed "Exhibit of Power Expense" will show the manner of distributing this division of shop expense.

EXHIBIT OF POWER EXPENSE.

	Steam Generating	Elec. C. Distr.	Power Trans.	Comp Air
Depreciation				
Insurance				
Taxes				
Changes				
Coal				
Belting				
Oils				
Waste & Supplies				
Water				
Repairs				
Sundry Expense				
Salaries (Ch. Engr. & Asst.)				
Wages (Firemen)				
" (Engineers, Oilers, Dynamo Men)				
" (Motor Cleaners and Oilers)				
" (Air. Compressor Attendant)				
Administration Expense				
Rent				
Steam for Engines and Condensers				
Power, Electric Current Generating				
" Electric Current Distributing				

Depreciation is the amount which must be set aside each year at say four per cent. compound interest to provide for renewals. Here the trained judgment of the engineer is required to estimate the probable life of the various parts of the power plant. This done, it is an easy matter for the accountant to turn to an engineers' hand book and find the proper amount to be charged operating expenses each year on account of depreciation.

The rate for insurance and taxes is not within the control of the cost accountant, but if overcharged, the amount can sometimes be diminished if adequate records are kept.

Charges is a variable item and includes such charges as are not covered by repairs and are not additions. They may be necessitated either by a change in the policy of handling power or by the growth of the shop, but in either case the amount should be included in the exhibit of power expense under the head of changes.

Coal is the largest charge to power expense. It includes not only the price of coal, but also the cost of transportation, demurrage on coal barges and watchman's hire. Some belting is, of course, used in transmitting power. Belt hooks and cement are also included in this subdivision. Oils may seem a small item but the exhibit is incomplete without it. Waste and supplies is an item, a detailed study of which will suggest economies, though it is of relatively small importance.

Water when purchased is often an item of considerable expense. If drawn from wells, the cost of maintaining same together with pumping should be exhibited under the head of water.

The replacing of old or new parts, which work does not increase the value of the power plant, should be assessed against repairs.

The salaries of the chief engineer and assistants, wiremen and millwrights should be assessed against the various divisions of the power expense account by estimate or analysis. The same holds true in the case of wages of firemen, engineers, oilers, dynamo men, air compressor attendant and motor cleaners.

It is customary to assess the non-productive labor of clerical departments who check up time slips, make out orders, do the necessary accounting and so on, against the other departments on the basis of the number of employees. Thus the number of men whose salaries or wages are chargeable to power expense is the basis for making the administration charge.

All expense incurred in the maintenance of the building, such as sweeping, cleaning, making repairs and changes, is included under the head of rent expense. This account is then closed out on the basis of the number of square feet of floor space occupied by the various departments.

The best practice is to give the power expense account a number and each subdivision another number to facilitate the classification of invoices, journal entries and so on. The principle in classification is always to classify a charge according to the use which facilitates distributing expense and is just as good a method as an alphabetical one for making an exhibit of shop expense. It is customary to include boilers, pumps, heaters, ash and coal conveyors in the steam generating system; engines, dynamos, switchboards, condensers and cooling tower in the electric current generating system; distributing cables and all wiring between switchboards in the electric current distributing system; motors, line and jack shafting in the power transmission system. The exhibit of power expense should be made comparative, one quarter with another, that any increase or decrease may be investigated.

That the cost per unit may be found, the power generated and transmitted must be metered. Steam, water, gas and air meters are periodically read and the results incorporated into the report on power which is the basis for assessing power expense against the various departments using same. The amount of power expense can be included with other departmental expenses in finding the amount to be loaded on labor in figuring the cost of production. Thus to find accurate costs of production, to include a detailed exhibit of power expense in a statement of shop expense, and to facilitate the practicing of economies in the power plant, an adequate system in finding the cost of power is required.

PRINCIPLE OF ARC REGULATION

Facts about Constant-Current Series Arc Lamps

By Geo. S. Neeley.

I note with interest the article on "Practical Hints about Arc Lamps," in the September number of The Practical Engineer, by Mr. Wm. Kavanagh. In reading this article I wonder how many engineers who have not had practical electrical training know to what class of arc lamp Mr. Kavanagh's article refers, particularly. For the especial benefit of those who might wish to know, I should say that the article in question refers to direct-current constant-potential lamps.

There is another class of arc lamp, which is entirely different, in respect to its arc-regulating mechanism, from the direct-current constant-potential arc lamp. This lamp is known as a constant-current series arc lamp, and I dare say that there is one of these lamps in use for every one of the constant potential variety.

While Mr. Kavanagh's article was intended to deal with the ills to which all classes of arc lamps are heir, I will endeavor to explain the principle on which the arc is regulated in the constant-current arc lamp, as I believe it will be interesting to some of your readers. There is little, if any, difference between the general construction of a direct-current or an alternating-current constant-potential arc lamp, the chief and only difference is in the regulating resistance, used to reduce the line voltage at the arc. A specific resistance in one form or another is used in the direct-current constant-potential lamp, while the well-known principle of induction is made use of in the alternating-current constant-potential arc lamp.

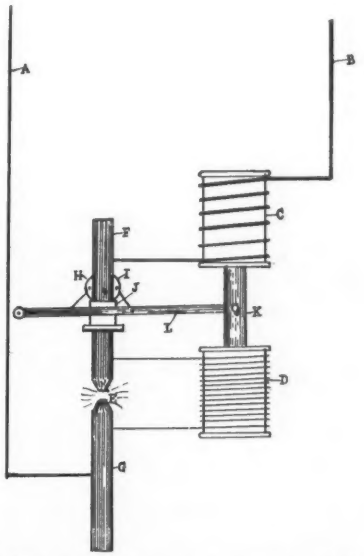
Granting that all engineers know something of the mechanism and the principles of operation of the constant-potential arc lamp, we will now take up the subject of this article.

In the constant-potential arc lamp a single magnet in series with the arc is sufficient for the regulation of the arc, but when we come to consider the constant-current series lamp, we have an entirely different set of circumstances to deal with, as when lamps are operated in series, they are supplied with current of constant value, which is accurately maintained so, if the regulator on the dynamo that is supplying the current is working properly. Now, as the current is always kept constant by the dynamo, it is very plain that the pull of a single-magnet in series with the arc will be unaffected no matter what the condition of the arc may be.

It should now be explained that while the current is maintained constant, the voltage across the arc varies with its length. This fact is made use of in the constant-current lamp, and a second magnet is added to the single-series magnet of the constant-potential arc lamp. This magnet is wound with a fine wire and its terminals are connected or shunted across the arc. For this reason this extra magnet is called the "shunt coil." The pull of the shunt coil is arranged so that it is exerted in just the opposite direction to that of the series magnet. From this we see that the constant-current arc lamp has two distinct magnets with different functions to perform. The pull of the "series magnet" tends to lengthen out the arc, while the pull of the "shunt coil" tends to shorten the arc.

Thus the action of these two magnets can be likened unto the action of two men pulling in opposite directions at the ends of a rope—when their forces are equal the arc is at normal length; when their forces are unequal the arc will be lengthened or shortened, according to which force is predominating. This is what is known as the differential principle, the difference between the pulls of the magnets being utilized to regulate the length of the arc.

For an illustration of the foregoing principles reference is made to the accompanying elementary diagram of a constant-current arc lamp: A and B are the wires forming a loop in the series, C is the series magnet, and bears the same relation to the constant-current lamp as it does to the constant potential lamp, D is the shunt coil, E is the arc, F and G are the carbons. When there is no current flowing the carbons F and G are together.



Mechanism of a Constant Current Arc Light

When current is turned into the circuit the series magnet C raises the carbon F and starts the arc at E, as the arc is lengthened the pull of the shunt coil D continues to increase until the pull of both series magnet and shunt coil are equal, when the condition of the arc E will become steady. As the carbons F and G burn off, the voltage across the arc is proportionately increased; this causes the pull of the shunt coil D to preponderate and carbon F is drawn down proportionately, until the feed mechanism H and I is brought into action by striking against the stationary ring J. K is an iron core common to both series and shunt magnets, all movements of the core K being transmitted to the carbon F and feed mechanism H-I, by the lever L.

The automatic cut-out, which is an essential with this class of lamp, is not shown or dealt with here, as it has nothing to do with the subject of this article.

When a lubricator works well for a time and then gives trouble, the trouble will generally be found to be due to dirt in the lubricator or connections.

THE NEW YORK CENTRAL POWER PLANT

Steam Turbine Plant at Port Morris

The New York Central & Hudson River Railway Company, in electrifying the steam line along the Hudson River, have installed power houses at Yonkers and Port Morris, the latter having recently been placed in operation.

Both of these electric power stations are constructed along the same lines and therefore the accompanying illustrations, Figs, 1, 2 and 3, of the boiler room, steam turbine and generator room, and switchboard gallery in the Port Morris plant, give a fair idea of the electrical equipment installed in both stations.

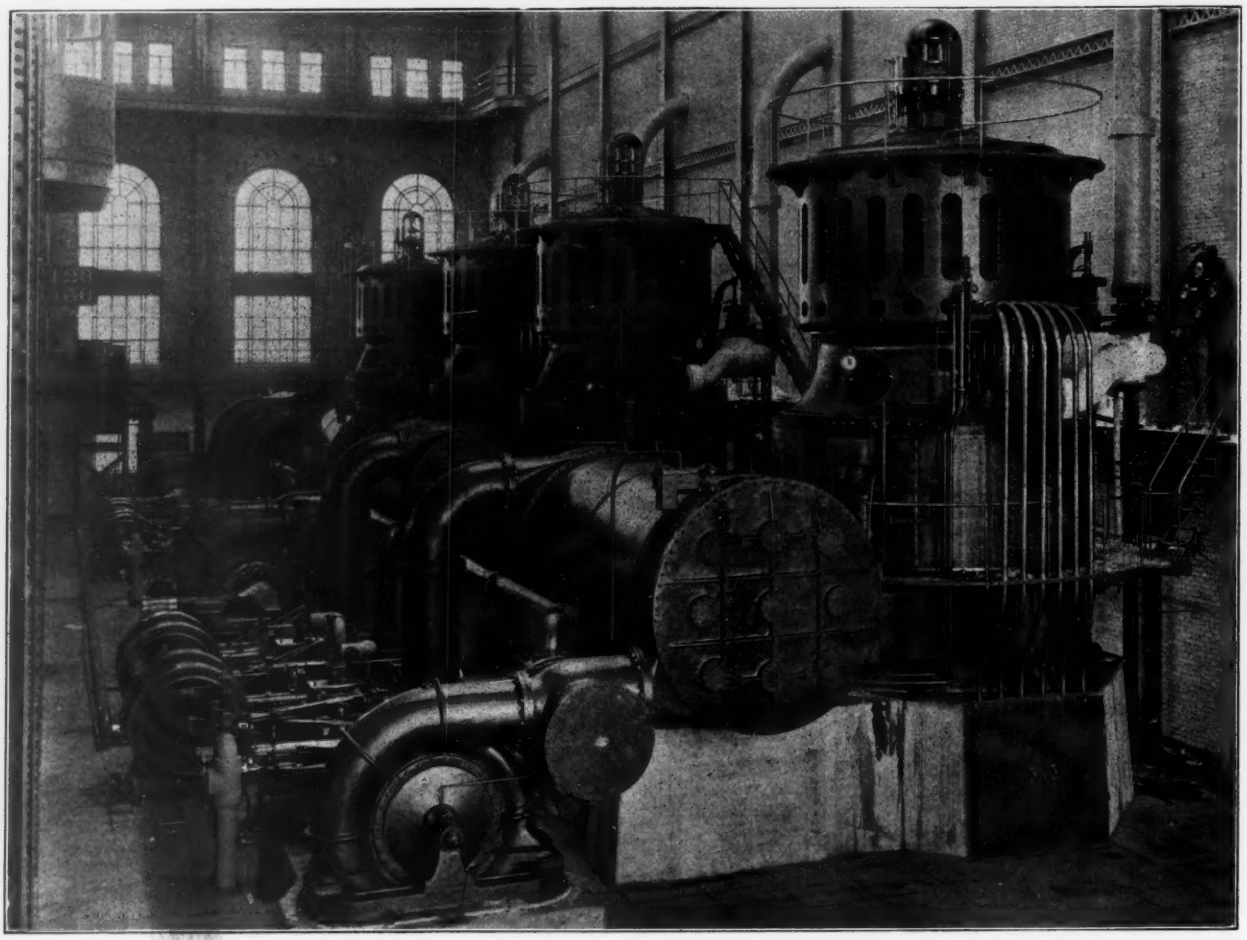


Fig. 2.—Generating Room of the New York Central R. R. Power Plant at Port Morris

The boiler plant and turbine and generator installation are in the same building, but divided by a brick wall along the length of the building, which is constructed of steel and brick on concrete foundations.

The boiler installation includes at the present time 16 of the 24 Babcock & Wilcox boilers ultimately to be utilized in this plant, which will have a total heating surface of 150,000 square feet, each boiler having a grate area of over 100 square feet and a heating surface of over 6,000 square feet. Superheaters are provided for each boiler, raising the temperature of the steam to 200 degrees Fahr. above the temperature, due to the pressure by means of over 1,200 square feet of superheating surface. These boilers will have a total horse power capacity of 15,000 horse power or over 600 horse power per boiler, operating at a maximum steam pressure of 200 pounds per square inch.

The coal bunkers surround the boiler room, and the present equipment of 16 boilers is arranged in two rows of 8 on each side of a central aisle, the boilers being fed with bituminous coal to Roney stokers, while the ash is delivered to hoppers below the boilers and the wash-out water is carried away from out-board drains at the rear of the settings, while the products of combustion are carried away by two radial brick stacks 250 feet high and a trifle less than 16 feet in internal diameter.

The superheated steam is conducted through the brick wall to the present installation of four Curtis steam turbines in pairs by 14-inch loops so arranged that four boilers supply the superheated steam to one turbine, and each turbine is connected with the boiler supply in such a manner that steam may be taken from either of the two banks or sets of four boilers,

while the auxiliary apparatus is connected between the adjacent turbines with the cross-connecting bands and thereby supplied with the necessary steam.

Gearing and shafting have been installed with a hand-wheel in the boiler room operating the main cut-off valve of the turbine, and a free exhaust pipe has been connected to each tur-

Fig. 1.—Boiler Room of the New York Central R. R Plant

bine separate from the exhaust of the auxiliary apparatus, which includes three pressure pumps, a large steam pump supplying each of the two accumulators, and a Worthington condenser having a cooling surface of 17,000 square feet for each turbine, tokether with Worthington air pumps, and centrifugal pumps for the water circulation.

A part of the pumps are operated by electric motors of 10-horse power each, such as the two-stage turbine hot well pump, while steam engines of the Fleming side crank type, noted at the left in the illustration, Fig. 2, are employed for driving the centrifugal circulating water pump.

The four turbo-alternators of the vertical type shown in the accompanying illustration, Fig. 2, each has a capacity of 5,000 kilowatts, and they were constructed by the General Electric Company of Schenectaday. These Curtis turbines are of the five-stage type directly coupled to vertical revolving field alternators supplying a polyphase current at 11,000 volts pressure and a frequency of 25 periods per second.

The electrical generators are capable of standing an overload, for a short period, equal to their normal capacity and, for several hours, an overload equal to half the capacity of the generators, while an efficiency of 90 per cent. is obtained with an output of 1,250 kilowatts, and 96 per cent. with an output of 5,000 kilowatts or full load.

For supplying the necessary exciting current to the revolving fields, a motor generator set is employed together with two steam turbine direct-current generator units, the former consisting of a 200-horse power motor taking a current from the alternating current service at 200 volts and a frequency of 25 cycles, and directly driving a direct-current machine delivering 1,200 amperes at 125 volts at a speed of 500 revolutions per minute. The latter two exciter units are of 150 kilowatts each, and consist of two horizontal steam turbines of the non-condensing type operating with a steam pressure of 200 pounds and delivering an exciting current of 125 volts pressure and supplying 1,200 amperes from each dynamo. A storage battery equipment has also been installed which will deliver 1,200 ampere hours at a one-hour discharge rate, 74 elements being utilized in this accumulator plant, equipped with two end-cell switches. The current from this battery is not only employed in connection with the exciter sets for supplying direct current to the turbo-alternator fields, but is also utilized for driving the direct-current motors operating the auxiliary apparatus, such as the pump and other mechanism, also supplying the necessary current for arc and incandescent lamps about the station.

A portion of the switchboard gallery is shown in the accompanying illustration, Fig. 3, mounted on a glass-enclosed structure, shown at the left upper corner of the illustration, Fig. 2, of the turbine and generator room. The remote control switchboard is installed in this gallery, separate boards being

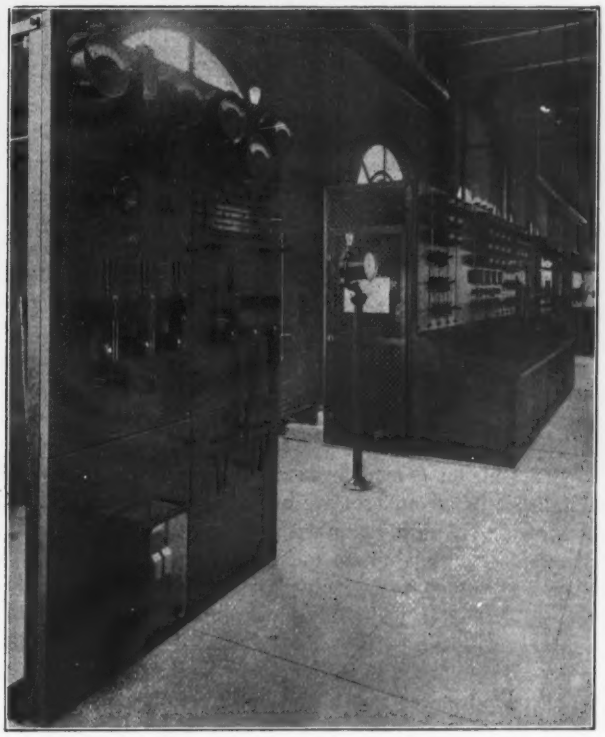


Fig. 3.—Remote Control Switchboard in the New York Central Power House

provided for controlling the exciter while the operating bench board is located in the centre.

The high-tension switching equipment is installed in a separate building from the main power plant. In this switch-house basement are installed the cables and instrument transformers as well as the high-tension connections. The switch-house is

100 feet long and about 50 feet wide, provided with fireproof compartment for the high-tension apparatus of the turbo-alternator. The oil switches are mounted on the first floor of this building and there is an auxiliary operating board as well as instrument panels for each pair of groups. The General Electric H. type of oil switches are employed with knife switches located in the lower part of the switch casing for disconnecting from the high-tension service. These oil switches have a capacity of 500 amperes and the tie switches 1,200 amperes.

There are two transformers of 300 kilowatts each supplying a three-phase current of 200 volts for lighting and power service in the switch house and turbo-alterantor room. Alternating current motors of about 250 horse power capacity are utilized for driving auxiliary motors in this station and direct-current motors of 180 horse power.

The current from the Port Morris station is conducted by overhead as well as underground power transmission lines to eight sub-stations, only a part of which have been connected by aluminum cables mounted on steel poles. These steel poles are mounted in concrete foundations and are provided with pine cross arms which carry the No. 0000 aluminum cables about three feet apart. The same size cables of the three conductor type are utilized for the underground transmission line, paper insulation and lead sheathing being utilized, the cables being laid in ducts of vitrified tile. These conduit ducts are covered with waterproofing and laid in concrete.

The current is conducted by these transmission circuits to the various substations, where the pressure is reduced by step-down transformers and the three-phase current changed to a proper current of lower voltage and conducted through feeders to the railway collector conductors after passing through the necessary transforming apparatus in the sub-stations.

PRACTICAL EXPERIENCES ON ELECTRICAL DRIVING

At the recent meeting of the National Association of Cotton Manufacturers, held at Lake Champlain, N. Y., Mr. John A. Fernley read an interesting paper, entitled: "Practical Experiences on Electrical Driving." Mr. Fernley takes up the subject from the practical standpoints which are continually presenting themselves to the cotton mill manager and superintendent.

Mr. Fernley says that while the subject of the electric drive has been fully covered, as pertaining to the desirability of installing an electric drive and the opportunity it presents to determine the horse power that is being used by the different departments or machines, yet he has never read of any disadvantage that may or may not be found in electricity as a motive power or the troubles that may at any time arise through its use.

In this connection Mr. Fernley says: "I do not think that anyone today seriously doubts that electrical driving has many advantages over either the rope or belt drive, and certainly the writer's experience has proved that they are neither few nor small; still, on the other hand, there are many people who think that its advantages are offset by its cost of installation, etc., coupled with a vague suspicion that it is not thoroughly understood, and is apt to cause a greater amount of trouble than either the belt or rope drive; and so conclude to stick to the old methods; while others who are satisfied as to its advantages as given by its advocates and friends, want to know what the results are in actual working, and whether it can be handled with success in an ordinary cotton mill, stating that while they are convinced of its advantages in general, they want to be enlightened as to its everyday working. As one practical engineer said to me some time ago: 'If I could only *see* what it is and be *sure* of what the result would be, I would feel more satisfied with its installation.' This remark simply goes to show that the average mill man is rather afraid of a force which is invisible to him and the component parts of which he is unable to comprehend.

"To be able to clearly understand and give full consideration to the arguments for or against an electric drive, we must keep in mind the fact that electricity is not a primary energy, but merely a secondary power that depends upon a mechanical plant to generate it. Coal must be used to develop the mechanical energy before the electricity is generated and, therefore, there is no advantage in this respect, the cost being about the same for the production of a horse power in either system, the difference being, that in one case the power has to be carried to its destination by a series of belts, thus providing one large unit from which all the subdivisions derive their power; while in the other it is developed into electricity and by wires carried to the switchboard for distribution around the mill and then subdivided into many units of different capacity, each one of which is entirely independent from the others and can be controlled either in the mill or engine room, without interfering with the operation of any of the other units.

"These units are known as 'Motors', and are simply a machine used to change the electrical into the mechanical energy, and depend upon the amount of electricity as expressed in volts and amperes, for their efficiency. Thus we find that a double process is required in electrical driving before the energy is at the point where it can be used, and between the changing of the steam power into electricity, and its conversion back into mechanical energy by the motor, there is quite a loss of power.

"When a motor is built it is wired and wound to perform a certain amount of work and is in two parts, termed the 'armature' and 'field.' The field is charged with the electricity from the generator and as a result the armature is made to revolve and thus operate the shafting. The higher the load, the more resistance there is to the action of the electricity and this produces a loss of speed which in some cases reaches as high as three per cent. between the full load and no load speeds. It will be readily seen that if the full current was thrown into the field at the starting of the motor, it would have to start at its highest velocity, owing to the fact that the load would be at its lowest point and this, of course, is something no machine could stand. To get over this difficulty, in each motor is placed what are known as 'resistance' grids, the

functions of which are to take some of the electricity away from the motors and thus enable them to be started at a sufficiently low speed, and after a few seconds these grids are gradually cut out or short-circuited and the motor brought up to its full speed.

"It is right at this point where one is apt to find out that there is more to the successful running of an electric plant than appears on the surface of things and where experience comes in to teach many lessons. In the first place it is necessary that some one shall be responsible for the starting up of the motors. The employment of many different people in the starting of motors involves danger from the fact that upon the way in which the work is done depends the whole power of that particular unit, for should the electricity be switched on with the resistance out, the motor is apt to be put out of commission; while on the other hand, if the resistance is left in too long they are liable to become overheated and weakened, with the result of the loss of that unit of power until repairs can be made."

Mr. Fernley says that he knows of several different cases where trouble has occurred and in one instance the grids were burnt out before the mill had been running very long and before the officials of the plant were aware of the desirability of having spare sets on hand, the only safe course being to have duplicate parts to forestall any difficulty that may arise should they give out. Mr. Fernley then says that the next thing of importance in the motor is the "air gap", or the space that is left between the revolving armature and the stationary field. The space is made as narrow as possible, owing to the fact that the permeability of air is very low, and therefore, the smaller the space, the greater the efficiency of the motor.

It will readily be seen that in a room where there is a large amount of dust and cotton fibres in the air, such as is found in card rooms, etc., that this air gap will soon become more or less filled with the same, and thus in a measure insulate the field from the armature and give the current an added resistance to overcome before doing the work of operating the machinery.

To overcome this it is necessary to have the motors thoroughly cleaned out, by blowing out this accumulation of dust and dirt. The time between such "blowing off" depends entirely upon where the position of the motor is, but Mr. Fernley inclines to the idea of giving it a good cleaning at certain stated intervals rather than to simply clean it a little every day.

About the only effectual way to get this lint and dust from the interior of the motor is to install a compressed air system, the pump for which may be placed in the engine room basement or other convenient place, and to carry this air by means of pipes to every motor in the mill, placing a valve on each side of the motor.

Then the electrician should go over the motors and inspect them, testing them with the gap gauge to see that there is no danger of the armature touching the field. This test should be carried out often, for upon it depends the very life of the motor.

In reference to the electrical generator, Mr. Fernley says that here we are confronted with a machine which has certain advantages over the belt drive but which also has some disadvantages. Continuing, he says: "There is no question, where a mill plant is overloaded to any great extent, that electricity is preferable to belt, from the fact that a belt will only carry a certain load, no matter what the capacity of the engine, while in the case of a generator you can carry up to 40 per cent. of an overload and this at a very small loss in comparison to belts. This is an advantage which most especially applies to mills which are run by two engines and generators, both being run together as one unit, from the fact that if one engine or generator is disabled, it is possible to throw a large proportion of the whole load upon the remaining generator, thus cutting down the loss to some extent, while with a belt drive the loss of the engine would be total. Still, even at this point there are possibilities of accidents that may occur which are not found in a mechanical drive.

"Before it is possible to obtain any power from the generator, it is necessary to charge the field with a current of electricity, thus producing a magnetism, from which the machine is built up. Should the 'exciter' in any way become useless, it would mean a total suspension, because no power could be generated; so that we have an added point of danger which is not present in an ordinary drive. After the generator has built up to its rated voltage, the current is switched into the machine, and a motor is used for the purpose of keeping the field excited. Should the motor fail to do its work, an instant shutdown is the result, with possibilities of the engine running away which can be imagined. I have had one such case, caused by the poles on the motor becoming reversed, but we started up the steam exciter and ran in this way until the motor was fixed.

"Another experience which I have had recently was the burning out of a number of pole pieces or coils, in one of the generator armatures. The engines seemingly were running with their usual smoothness and were carrying a load *under* their rated capacity. The generator was apparently all right, when about eight o'clock in the morning, a noise resembling somewhat the roar of a cannon came from the engine room. As soon as possible the engines were shut down, but it was impossible to find out at first what the trouble was, owing to the room being filled with smoke, but eventually it was found that a large hole had been burnt through the coils, and that the solid iron casing had been burned away. Apparently, there was no cause for the accident, except that it might have resulted from an imperfectly insulated coil.

"Apart from such troubles as these, there is no doubt but that electrical driving is advantageous, and in a large plant, more economical, than the mechanical. It is very flexible and requires a minimum amount of shafting.

"In reference to the amount of power used, there seems to be but little difference in the loss on an electrical and mechanical drive, so far as getting it to the room is concerned, but there is a decided advantage in favor of electricity after it reaches the motor."

In opening the water glass connections after putting in a new glass, it is generally recommended that the pet cock at the bottom of the glass be opened first and then the steam valve at the top, thus allowing steam to blow through the glass and warm it gently. Next open the water valve and close the drain at the bottom of the glass. If water is admitted first, and then steam, the glass will often break, because the water is much cooler than the steam and there would be a greater expansion in the upper half of the glass than in the lower half.

ALCOHOL AS A FUEL

Regulations for Denaturing Just Issued

The regulations for the denaturing of alcohol, which follow and render effective the law enacted by Congress at its last session and which provide for the withdrawal from bond, tax free, of domestic alcohol, when the same is rendered unfit for beverage or liquid medicinal uses by the admixture of suitable denaturing materials and for the use of the denatured article in the arts and industries, and for fuel, light and power, were issued by John W. Yerkes, Commissioner of Internal Revenue, on October 6th.

The new regulations provide for two classes of denatured alcohol: First, that completely denatured, which will pass into general use for consumption, and, secondly, "specially denatured alcohol," or that in which the alcohol will be denatured according to the needs of the manufacturing interests.

For the completely denatured article, 10 parts of wood alcohol and one-half part of benzine will be added to 100 parts of ethyl alcohol; that is, to every 100 gallons of ethyl alcohol will be added 10 gallons of wood alcohol and one-half gallon of benzine.

The denaturing process will be accomplished on the distillery premises, where the alcohol is produced, and in special bonded warehouses designated and used alone for denaturing purposes and for the storing of denaturing materials. These buildings and the operation itself will be under closest governmental inspection and control.

It is expected that denatured alcohol will supplant very largely the consumption of wood alcohol for both domestic and manufacturing purposes. While the price of the completely denatured alcohol cannot now be definitely stated, the government authorities think it will not be more than 35 cents a gallon at present, although a price of 25 cents is thought to be about what may be expected. What a few writers think about the use of this denatured fluid for power purposes follows:

An article by Elihu Thomson, in *Cassier's,* for August, discusses alcohol as a fuel. The enactment of the new law respecting denatured alcohol gives this article particular interest. Mr. Thomson says in part: "We have in ethyl alcohol an ideal fuel—colorless, limpid, of moderate boiling point, about 50 degrees below that of water, non-freezing, burning without smoke, mixing with water in all proportions, and, therefore, its flame extinguished by water, cleanly, drying off completely when spilled, not attacking rubber gaskets or packings, and non-corrosive for metal tanks and holders.

"The fact that its flame is bluish or so-called non-luminous, means that the flame is almost devoid of free carbon particles, with its intense heat-radiating power, a fact of considerable importance. When gasoline or heavy oils are burning, the flame, loaded with free carbon or soot, radiates heat to such a degree that it is not possible to approach near the conflagration, and combustible surroundings are readily fired by pure radiation of heat.

"The production of alcohol on a large scale is very simple and the raw materials already exist in considerable variety. All saccharine or starchy growths are available. Saccharine wastes are now largely used in Cuba for alcohol production.

"This alcohol will, in a properly organized engine, equal, volume for volume, gasoline now sold at a much higher price, in producing power. Even in the immediate future, then, it is evident that alcohol has a large field of usefulness. The farmer need not depend on wood, coal or oil for his power. His agricultural wastes will furnish it. His fields need only receive the sunshine, and be given sufficient water, and thence any crop yielding starch or sugar, however unmarketable otherwise, may be made the source of power, light and heat."

The *Electric World* says on the same subject:

"It seems to be generally agreed that in an engine of given cylinder dimensions and speed, alcohol when properly used will produce a greater output than gasoline—in the opinion of one of our best-known engine-builders, to the extent of some twenty per cent. The gain is mainly due to the greater compression at which it is possible to work the alcohol without producing autoignition; hence, the greater the expansive action obtained, the lower the temperature of the rejected gases, and the higher the thermal efficiency. It is understood that with a proper engine the thermal efficiency may be raised to and above 30 per cent., while with gasoline the efficiency would be nearly ten per cent. lower. In point of safety, too, the alcohol has a very considerable advantage in that it has a very much lower flashing point than any petroleum product that can be readily worked in an internal-combustion engine. Of course, even crude petroleum can be so used, if necessary, but far less easily than the hydrocarbons of lower boiling point."

Other advantages are that alcohol burns with a pale blue flame with little radiated heat and no soot. Its heat is delivered mainly by convection, as in case of a Bunsen burner, so that the danger of overheating objects near the flame is lessened, and an alcohol fire can be put out with water, because it mixes with the water, instead of floating on it, as gasoline does. Again, the odor of alcohol is inoffensive, while that of gasoline is most disagreeable.

To quote further: "So much for alcohol in the open air or in storage. In engines it works admirably, giving very clean combustion, of which the main product is water vapor. Less easily vaporized than gasoline, it still is readily enough managed, and, as we have seen, gives excellent efficiency. As to actual costs in operating alcohol engines, data differ somewhat. A few engines have been sent from this country to Cuba, where they are worked on alcohol costing ten to twelve cents per gallon for a spirit quite good enough for the purpose. At this price, gasoline would be at rather a disadvantage, assuming equal dynamical value per gallon. Prior to the passage of the recent bill, such spirit would have carried a prohibitive tax, some $4 per gallon. Even now it will have to carry some extra charge for denaturizing. Wood spirit, much used for this purpose, is much more expensive than the alcohol itself, and pyridine, the other substance considerably used for denaturizing, is far from cheap, and has a most infamous odor.

ELEMENTARY ELECTRICAL ENGINEERING.

External and Armature Characteristic.

By Jacob Glogan.

Part III.

The external characteristic of a shunt dynamo shows the effect of the increase of armature current upon its terminal electro-motive force, when no attempt is made to regulate the voltage of the machine. It is the measure of the inherent regulation of the machine for constant potential. If the resistance of the armature is large, the voltage drop is large, and consequently the regulation is poor; if the resistance of the armature is low, the regulation is good.

If a shunt machine be self-excited to its rated electro-motive force and the current through the armature is increased by adding lamps to the external circuit, the electro-motive force of the armature terminals would gradually decrease, due to the current and resistance loss in armature and this would in turn decrease the field current. When the field current becomes so decreased that any further decrease widely changes the electro-motive force, both this force and the current will rapidly decrease to zero and the external characteristic will take the form of the curve shown in Part I. In the event of a shunt dynamo becoming short-circuited, this action takes place accompanied by violent sparking and mechanical strain.

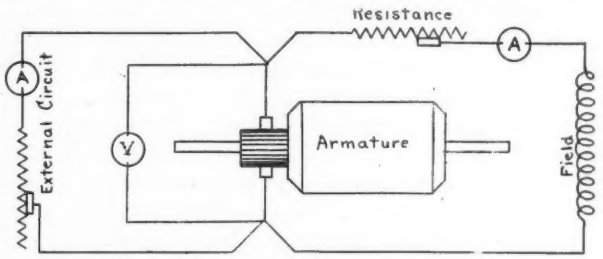


Fig. 1.

When making this external characteristic curve, the machine should run at constant speed, the voltage should be fixed and the external current should be increased until the machine fails to generate, the field resistance also being kept constant. The diagram of connections is shown in Fig. 1. In laying out the curve, the amperes delivered by the armature are plotted along a horizontal line, while the volts generated are plotted in a vertical direction, as explained in Part I of this series.

The armature characteristic expresses the relation between the external and the field current, the voltage in this case being kept constant and the armature run at constant speed. A curve plotted from the results obtained in this test shows the increase in field ampere turns necessary to compensate for the drop in voltage due to the increased external current. The total change in the ampere turns divided by the maximum number of ampere turns used will give the percentage increase under any condition of load. This method gives the value of ampere turns used to change a shunt dynamo to a compound wound dynamo; dividing the maximum increase of ampere turns by the external current will give the actual number of turns necessary for the series coil winding. The connections for finding the armature characteristic are also shown in Fig. 1. Readings are taken of the external current and field currents, speed and voltage being kept constant.

Suppose, for example, the mean length of each turn of the field coil was 28⅛ inches, the resistance of the coils was 83.3 Ohms and the coil weighed 20 pounds and was composed of No. 20 wire. Then, from the resistance tables, we find that it requires 4.1 Ohms of wire to make a pound, or each Ohm requires .24 Ohms, and also that 1000 feet is equivalent to a resistance of 10.29 Ohms. Since there are 83.3 Ohms in the coil, $(83.3 \div 10.29) \times 1000 = 8090$ feet of wire in the coils, and since each turn contains about 28⅛ inches, this length is equivalent to approximately 3500 turns. Throughout the range of load, the change in amperes in the field coils if the given dynamo was .8 to 1.0 or 0.2 change, so that $3500 \times 0.2 = 700$ ampere turns required to keep a constant potential.

The maximum number of amperes in the field was found to be one ampere, so that the maximum number of ampere turns employed to generate the voltage was $3500 \times 1 = 3500$ ampere turns and $700 \div 3500 = 20$ per cent. increase, which will be required to maintain the voltage constant.

Production of Coal in 1905.

Both in quantity and value, the production of coal in 1905 surpassed all previous records in the history of the United States. The output, according to a forthcoming report of Mr. Edward W. Parker, statistician of the United States Geological Survey, amounted to 392,919,341 short tons, which had a value at the mines of $476,756,963. Compared with 1904, when the production amounted to 351,816,398 short tons, valued at $444,371,021, the output in 1905 exhibits an increase of 41,102,943 short tons, or 11.7 per cent. in quantity, and of $32,385,942 or 7.3 per cent. in value. Prior to 1905 the maximum output of coal was obtained in 1903, when the production amounted to 357,356,416 short tons, valued at $503,724,381, compared with which the record for 1906 shows an increase in production of 35,562,925 short tons, and of $26,967,418. The high value recorded in the statistics for 1903 was due to the somewhat abnormal inflation of prices, caused by the shortage of fuel supplies, which resulted from the strike in the anthracite region of Pennsylvania in the preceding year. The lower values in 1904 as compared with 1903 were simply a return to normal conditions, but the decline in 1905 was the result of a production in excess of market requirements, unusually large as they were.

Of the total production in 1905, 69,339,152 long tons (equivalent to 77,659,850 short tons) were Pennsylvania anthracite, with a value at the mines of $141,879,000. The total production of bituminous coal and lignite was 315,259,491 short tons, valued at $334,877,963. The production of anthracite coal in Pennsylvania in 1905 was 4,020,662 long tons (or 4,503,151 short tons) more than that of 1904, while the increase in the production of bituminous coal and lignite was 36,599,882 short tons. A portion of these increases in both anthracite and bituminous production was due to the efforts of operating companies to provide a supply of fuel in anticipation of a suspension of mining in April, 1906, when the wage scale agreements in the organized coal-producing States and the award of the Strike Commission in the anthracite region of Pennsylvania would terminate.

The larger part of the increased production in 1905 was due to the great activity in the iron industry, as is shown by the fact that the amount of coal made into coke increased from 31,278,537 short tons to 42,412,328 short tons, and that the larger increases were in the States that produce coking coal and those which furnish fuel to the iron furnaces.

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Conditions for Best Thermal Efficiency.

The coming use of denatured alcohol for use in internal combustion engines and the increased thermal efficiency which it is expected will result from the use of this hydro-carbon fluid have given an impetus to the discussion of what constitutes the best conditions for the maximum production of energy in heat motors.

The thermo-dynamic efficiency of energy conversion in the heat engine in practice, has been and always must be improved by increasing the temperature range of the cycle in the most practical way. In the steam engine, this extension of the temperature range has been effected by increasing the temperature and pressure of the boiler steam, no practical method having yet been found whereby the lower limit of temperature can be further depressed. And yet it is always more profitable to extend the range of temperature downward than upward because the fractional formula for the efficiency contains the range of temperature in the numerator and the initial temperature in the denominator. The larger the former and the smaller the latter, the greater will be the efficiency. In the gas engine, the upper limit of temperature is enormously elevated as compared with the steam engine, but the lower limit is also increased, so that there is even more lost heat than in a steam engine.

In all heat engines there are two efficiencies which must be considered: the thermo-dynamic efficiency and the mechanical efficiency. The thermo-dynamic efficiency, or the efficiency of the machine as a heat engine, is increased by any arrangement which shall make it practical to prolong the expansion of the working stroke throughout the full temperature range between the boiler and the condenser. The mechanical efficiency of the machine is improved by any device which will make the friction losses of the machine as small as possible. Theoretically, there is no thermo-dynamic limit to the expansion of steam in a steam engine, except the temperature and pressure of the condenser, but practically there is a point where further expansion would result in a loss due to the increased cost in producing that added power. The losses, which more than offset the gain due to increased expansion, are due to conduction and radiation and increased friction of the engine caused by a necessary enlargement of the engine due to a diminished mean effective pressure. When the increased range of expansion adds less work than is lost in trying to increase the efficiency, then it is useless to try to increase the efficiency in that way.

Much has been said in favor of volatile liquids, of which alcohol is one, based upon their low latent heats, but thermo-dynamically all have similar efficiencies under similar conditions and their relative values in practice depend not so much on their ideal efficiencies as upon the cleanness and convenience in the use of the fluid, its cost and safety, and the relative size of the engine to produce a given power.

In comparing the steam engine with a gas or vapor engine, the comparison often results unfavorably to the gas engine, due to the necessity of artificially cooling the cylinder walls, but on the other hand the statement is often made that less latent heat is lost in a gas engine owing to the lower capacity of latent heat found in the volatile fluids and gases.

The oft-repeated statement that all latent heat constitutes a waste and therefore volatile fluids and gases have a decided

thermo-dynamic advantage is absolutely wrong. In the steam engine, for instance, under the usual running conditions, it is this latent heat that supplies by far the greatest amount of work. Latent heat, whether due to change of state in a non-volatile fluid or whether due to isothermal expansion in a perfect gas, must be utilized to insure maximum efficiency of the heat cycle and the highest economy of the engine, and the larger the proportion of heat so utilized, the greater the work done and the better the heat engine.

In the gas engine, the greatest thermal loss results from the water jacket, and if all the heat could be retained in the explosive mixture during combustion, a decided improvement in internal combustion engines would result. It is radically wrong in gas engine design to increase the high temperature of compression and then carry that heat away by the water jacket. It is true that the initial temperature heat should be made as high as possible in order to realize the maximum efficiency, but some method should be used to insulate that heat, if possible, by using some more non-conducting substance than water during combustion.

The efficiency of the present type of internal combustion engine cannot be greatly improved so long as the high temperature of combustion is permitted to come into direct contact with the comparatively cool cylinder walls. Since, however, it is difficult to use other substances than water for jacketing, it might be expected that multiple-cylinder internal combustion engines may come into use, the endeavor being to secure a better adjustment of temperature and pressure range in the two cylinders than can take place in a single cylinder.

The time may soon come when multi-cylinder gas engines will be used for the same reasons that multi-expansion steam engines are now used.

—o—

What Should be the Education of an Engineer?

There are many men in the engineering profession, good engineers too, who, when the question of education arises, claim that experience is the best teacher and that anything pertaining to theoretical training is more or less "high falutin" and is not necessary to the making of a successful engineer.

Perhaps the best argument that can be advanced to offset this statement is to take the opinion of those engineers who are more advanced in years, who have grown old listening to the throb of the reciprocating engine and who still continue in the top notch of their profession.

One of these men is Capt. Crawford, of the U. S. N., who, though his hair is white, gave the following advice to the representatives of the N. A. S. E. attending the recent 25th annual convention: "Do not rely too much on experience, because experience is very often nothing more than a synonym for old fogyism. I have met many, many men who just rested their success upon their experience and that is fatal. You must keep up with the times. It is a duty to yourself, it is a duty to your employer to be right up fully abreast of the times in your knowledge of the steam engine and the boiler and in all that pertains to them. It is a duty to yourself to know the latest things, and the man who relies upon his experience alone commits a fatal mistake—fatal to his own best interest. I am not a theorist, but eminently practical myself. I have had large experience, but I assure you I have done all that I am capable of doing to keep abreast of the times in my profession."

In connection with the education of an engineer, Capt. Crawford also gave some timely advice, because in these days when opportunities for education are so easy to be had, it behooves one to be careful to select those things which will be of the most benefit to him. In this connection, Capt. Crawford said: "The engineer should be well schooled in elementary physics and in the principles of physical science on which everything depends with reference to the steam and steam engine. He should know and be able to demonstrate what the engine is doing at every point of the stroke. He should be able to consider its economy in every particular, the influence that is being exercised upon the piston at any point of the stroke, and the effort that is being transmitted to the machinery and for which the engine is employed to furnish power. He should have a knowledge of elementary chemistry because there is so much in boiler corrosion and in the formation and prevention of scale.

"These are all matters which the stationary engineer needs to be well informed respecting; and a little reading, a little study will give one the desired information. I believe furthermore that every stationary engineer should not only be provided with a set of drawing instruments, but should be able to make notes and drawings of any part of his machinery should it at any time become broken or deranged or require repairs of any sort. These can be sent off anywhere, because anybody can interpret a drawing. Trouble may occur here, but the drawings can be sent to France if necessary, for drawing is the same in all languages. The Frenchman understands it as well as the Englishman, and the American as well as any of them. It is the universal language of which every engineer should be possessed. He should also have an intimate knowledge of materials and their characteristics and strength and method of testing same. All materials should be subjected to test for the purpose for which they are to be used.

"There are any number of elementary works on these things which are very readable indeed. The indicator, of course, the engineer must know. That is his stethoscope, the thing that he applies to the machine to find out how its internals are working, whether satisfactorily or not. You cannot get along without an intimate knowledge of that.

"Now as to the practical preparation of an engineer. I believe that every engineer should be able to handle the ordinary tools of the machine shop. It is highly essential and greatly to his advantage if a part of his machinery has to be sent to the shop for repairs to be able himself to say how this or that part should be repaired, and if renewed just what degree of exactness should be reached, and how it will be done, the material to be employed, and everything of that kind. Two or three years of shop practice is an essential thing for an engineer, whether marine or otherwise. I had four years of it myself, and I regard it as about the best part of my training for engineering. I would advise every engineer to have a little library of his own, books pertaining to his business, and as a part of that library a T-square, a drawing board, triangle, universal curve and a nice set of well put together drawing instruments."

Coming, as this advice does, from one of the veterans of the engineering profession, it causes one to examine himself in the mirror of reflection and thus see himself as others see him.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Correct Indicator Diagrams.

EDITOR THE PRACTICAL ENGINEER:

We were very much interested in your article "Correct Indicator Diagrams," in the September number, and agree with you fully in your remarks concerning the importance of having the reducing motion correct. Having thousands of students and correspondents all over the world, we believe we are called upon to criticise more indicator diagrams than any other institution, and have noted, as you state, that engineers are too apt to concentrate their efforts entirely on the indicator and spring, and pay but little attention to the reducing motion.

Our instruction papers on reducing motions are most exhaustive as well as the examinations, and we find more ignorance regarding this branch of indicating than any other. We hope, at an early date, to give you some specific instances bearing out the truth of these statements and the arguments advanced in your editorial. We also hope that you will devote an occasional article in the future to further enlightenment on this important point.

Newark, N. J. Lippincott Steam Specialty & Supply Co.

Merits of the Metric System.

EDITOR THE PRACTICAL ENGINEER:

In the July issue there is a letter from F. H. S., in regard to the merits of and objections to the metric system. As I have been compelled to use both the metric and the foot system at different times, my opinion may be of interest to some of your readers.

I remember quite well when the metric system was in its infancy in Germany; also many of the troubles which were experienced from the change of the commercial "Elle" and feet into meters. Up to this day some of the older people will not buy anything but by the "Elle." This is especially the case in the dry goods line, in country districts. But merchants and mechanics were soon convinced and could see into the merits of the meter and were not slow in adopting it.

Why engineers in this country should be the chief opponents I cannot see, as engineers in Europe are using the meter right along for the same kind of work. And I am positive that the engineer of America is just as quick in grasping a good thing as the engineer of any other country.

The dimensions of pipes, tubes and wrought iron bolts, etc., are the same all over the world and are yet bought in some 40 civilized countries, where the metric system in used, by inches. But most of the up-to-date manufacturers and consumers will sell and buy their material by expressing the dimensions in millimeters (1000th part of a meter). The only objection in this regard that I can see is the quite lengthy expression in millimeters. Say, for instance, you ask for a piece of pipe one inch in diameter, you would be compelled to say 26 millimeters in diameter. But you know there is nothing like getting used to a thing.

During a trip through Switzerland, several years ago, I happened to mention the size of pipe in inches, while speaking to a friend. He was surprised that a progressive nation like the American was using the old system of foot and inches yet. This fellow I tried to convince, while I knew that in calculations and so on the metric system was better, that it was much more convenient and shorter to express those dimensions in inches. (Of course, I was accustomed to it.) But I did not get very far and I was soon convinced that the meter was a good all-around measure and should, and no doubt, before many years are over, will be adopted all over the world.

While it is hardly possible to change the manufacturing of pipes and pipe fittings into even fractions of the meter, it would not be so hard to do so in the manufacturing of wrought iron. But this change is not necessary, as those dimensions can very well be expressed in millimeters.

While being well satisfied with and very well accustomed to the decimal system of this country, I would like to see the metric system, after it is adopted by the United States Government, in general use all over the world.

Williamsport, Pa. A. M. M.

Water Affects Different Engines Differently. Look Out for Drip and Drain Connections.

EDITOR THE PRACTICAL ENGINEER:

I note in the July number, an article stating that slide-valve engines are less likely to cause accidents from water in the cylinder than other engines. While this statement is true to a certain extent, because most slide-valve engines belong to the old-fashioned engines of slow motion where the valve is not held up by anything except the steam and that often reduced in pressure by throttling, I would call attention to the fact that slide-valve engines, as now made, for high speeds and automatic governing, with large valve held in place by pressure plates or otherwise, are no safer than other kinds of engines and this fact is borne out by experiences of breakages in such engines.

It is astonishing how much water will pass through some engines without trouble or any sound whatever. I have run a Corliss horizontal engine, which owing to accidental salt in the boiler feed water, was frequently subjected to large quantities of water, the horizontal discharge pipe of the exhaust frequently being half full of water and half steam, but the engine never seemed to care or to receive any damage from it. I also run a small upright four-port slide-valve engine which sometimes, owing to the boiler priming, would seem to work on nearly all water but without damage.

On the other hand, a popular slide-valve engine whose makers claim safety from water by reason of the valve lifting, is always breaking its valves and pistons. At a nearby electric station the upright four-slide valve engines are frequently breaking valves without the engineer knowing why and they never are troubled with wet steam. Again, a large rolling mill Corliss may be completely wrecked by a single dose of water.

There is a great difference between engines about receiving damage from water, the reason for which should be ascer-

tained and taken advantage of. Care should be taken that separators are large enough, especially the drain pipes and traps connected thereto. They should at least be 25 per cent. of the capacity of the steam pipe for safe emergencies.

The wrecked engine mentioned above had a separator with a drain pipe one-fifth the diameter of steam pipe, but with the trap-valve opening of one-third the diameter of drain pipe, so when water once came, it could not leave fast enough and went to the engine wrecking it. Therefore have separators of not necessarily large size but of large operating capacity and traps of full flow construction.

Another point on water danger is drain pipes, which I often see constructed in a positively dangerous manner; that is, both ends of the cylinder piped to the ends of a tee and the side opening thereof connected to the discharge. With this arrangement, when a stroke is commenced, the entering steam would blow the water out of that end of the cylinder with a power and velocity due to the pressure, but the water would not quietly stop and drop out of the side opening of the tee but by reason of its velocity and momentum, it passes on and into the other end of the cylinder in front of the advancing piston, which, of course, is dangerous, and yet this arrangement is of frequent occurrence.

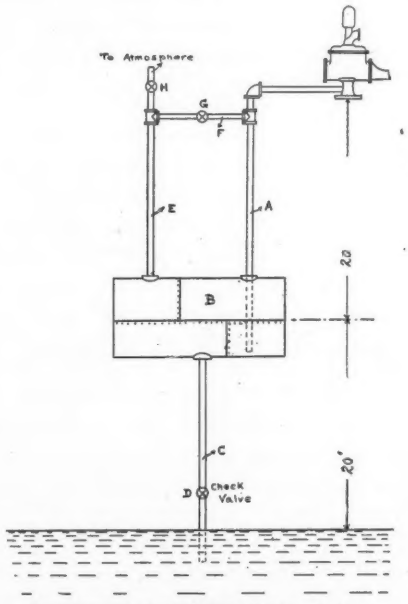
In all connections to separators and cylinders, have things so that water can flow away freely and in a safe manner.

Rochester, N. Y. F. R. W.

Method for Lifting Water 40 Feet.

EDITOR THE PRACTICAL ENGINEER:

The right method of connecting a pump in order that it will lift water forty feet and deliver it to the boiler is shown in the accompanying sketch, in which we have a suction pipe A extending into and within 1½ inches of the bottom of an



Arrangement for Lifting Water 40 feet

air-tight tank B, holding say 1000 gallons and situated midway between the water level and the pump. Another pipe C, in which there is a check valve D, connects the tank with the water.

Thus far, there is simply an air-tight suction line 40 feet long, the tank B being merely an enlargement of the pipe half-way up. E is an air pipe extending just through the top of tank and is connected with the upper suction pipe A by means of a by-pass F. A globe valve G is placed in the by-pass and one is also placed in the air pipe E above the by-pass connection, designated at H.

In starting, close valve H and open valve G; this allows the air to be exhausted from the lower suction pipe C and the air-tight tank B through the air-pipe E and the by-pass F. Of course, in starting up, and until water has attained a depth of 1½ inches in the tank, some or all of the air may take a direct course up through the upper suction pipe A; but after it has reached a depth sufficient to submerge the lower end of pipe A, the rest of the air will be exhausted through the by-pass; hence the necessity of the by-pass or some similar arrangement.

As the air is exhausted, the water will be forced up the suction pipe C, into the tank B, until it is full, and possibly a short distance up the pipes A and E; then open valve H and the air rushes in and destroys the vacuum, which is holding the water up this far, and the water starts back down the suction pipe C, when the check valve D closes and we have the main body of water trapped 20 feet from the pump with atmospheric pressure on it. Then by closing valve G in the by-pass, the pump will lift the water the rest of the way and deliver it into the boiler.

Cambridge, O. SCOTT.

An Emergency Flange Repair.

EDITOR THE PRACTICAL ENGINEER:

We were refitting an old plant with a new steam line from boilers to engines and the work was progressing nicely when Jack found a flange that was cracked and had to break it off. This was rather unfortunate, as we were trying to get the main header in position to cut in, so the plant could start up on time the next morning. As it was on Sunday, everything in town was closed up and as there were no machine tools at the plant large enough to serve, should we need them, we seemed to be in the middle of a pretty bad fix.

In searching over our list, we found we had one 16-inch flange to spare, but when we tried it on the pipe it was found to be too small and would not screw on more than two threads. It was getting along in the afternoon and time was becoming more and more limited, when at last we decided to put it on hot. We were afraid it would crack, but it was the only chance. We had been working on the flange for some time and had coaxed it to screw on three threads fairly easy, so locating the bolt-holes in their proper position, we marked the flange and pipe so we could have a guide when needed for placing the flange on the pipe.

The piece of pipe was located in an inclined position, with the thread end at a convenient height for working and held from turning by two pairs of chain tongs. A piece of ¾-inch pipe was then capped and drilled with ⅛-inch perforations, after which it was bent in a circle with the perforations on the outside and just small enough to slip easily inside of the pipe. An ell was screwed on the end of this pipe and a ¾-inch run made from 1-inch inside the top end of the pipe to a hose connection at the bottom end. An old piece of thin

sheet iron found in the plant scrap pile was used to make a disc that just fitted the inside of the pipe at the top end. This was to prevent the water from spattering out on the hot flange.

A portable forge was used to heat the flange to an even, dull red all over and when this heat was reached, the water was turned on at the hose connection to keep the pipe cool. The flange was handled with iron rods through the bolt holes and was screwed back to its proper position without trouble. Care was taken in cooling not to hurry matters too much and the job turned out all right.

E. Greenwich, R. I. L. L. ARNOLD.

Some Pump Troubles. Cause and Remedy.

EDITOR THE PRACTICAL ENGINEER:

Some time ago my attention was called to a few slight repairs in a neighboring plant that I think might interest some of the many readers of THE PRACTICAL ENGINEER. The plant was a small pumping station containing two triple tandem compound, duplex pumping engines, operating condensing, and each of about two million gallons capacity per day; also two independent air-pumps, two duplex boiler feed pumps, and a battery of four horizontal tubular boilers. The engineer had been to see me repeatedly and complained that he was having considerable trouble with the steam chest covers breaking on one of the high-pressure cylinders. I thought that the best way to straighten out the trouble would be to go to the station and look over the pump and see for myself just what was wrong. I soon arrived at the station and after a hurried look around, I suggested to the engineer to start the other pump, as the one in service was the one that he had been having the trouble with. The pump was soon cooled sufficiently so that we could take off the jacket and lagging. We soon took off the iron jacket K and K', as shown in the accompanying sketch, Fig. 1, and to my surprise there was absolutely no asbestos lagging whatever on either the steam chest or cylinder.

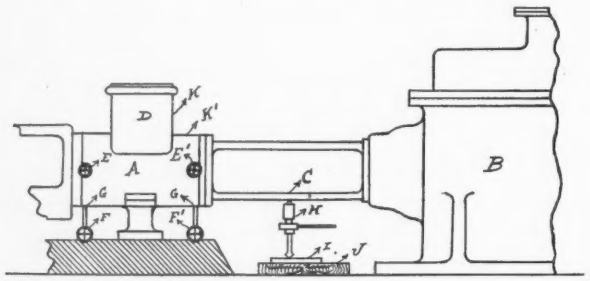


Fig. 1

After the cylinder was stripped, we removed the steam chest cover (or pressure plate, as it is sometimes called), and found it broken or sheared off very similar to what is shown at A and A', in Fig. 2. The engineer informed me that this was the third cover that had given out in this manner in three weeks' time, and that he was at a loss to know what had caused the pressure plates to give out. I asked him if he didn't have trouble with the lower joint of the steam chest leaking? He said he did, and that he had to use a special gasket for the joints, one made of sheet copper, and that he always followed up the joint when it was cold. The result was a natural one; the cast-iron cover would not stand the strain of expansion and the fractured cover was the result.

While we were discussing the matter, the engineer said that he would telephone to the shop for a new cover so that he could get it by express the next day, when I suggested to him to wait until we had gone over the entire matter and had seen just what was needed. I then asked him if he had any tools in the plant, and he said he had a ratchet and a few taper square shank drills, and a little "old man." "Have you any iron bars, say ½ inch thick by 2 inches wide by 6 or 8 inches long?" "Yes, I have," said he, and he produced several pieces that were quite adaptable as lugs to repair the broken cover. We found one of the flat drills to be 1⅛ inch in diameter, this being large enough to drill the larger hole for the steam chest stud to clear nicely, the stud being 1 inch standard.

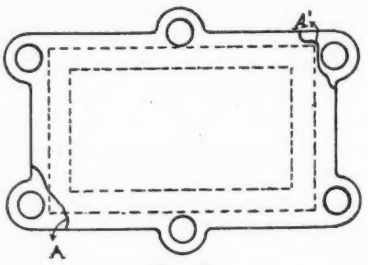


Fig. 2

The engineer complained that we could not drill the holes in the lugs because the "old man" would not take in the ratchet alone, let alone the drill and the work. I smiled at him and in the accompanying sketch at H in Fig. 1, is shown how the lug was drilled, at I is shown the lug, and J the wooden block it rests on, the centre of the ratchet being let in to the cradle at C. The holes in the pressure plate for the tap bolts as shown at A and A' in Fig. 3, were drilled in the same manner as those in the lugs, with the exception of the size of the drill, which was much smaller. The heads of the tap bolts A and A' are shown to be higher than the boss at D in Fig. 3, but this does not interfere in any way with the false cover.

I noticed a constant clicking at each end of the high-pressure cylinder, while this pump was running, and I questioned the engineer as to whether he had any trouble with the discs of the indicator valves E and E' or the drain valves F and F', and his reply was that he had to renew them every time he changed over the pumps; that at times they would not last a week.

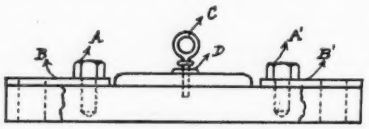


Fig. 3

For a remedy, we got some asbestos mill board of thickness under 1 inch, the engineer producing ample to cover two such cylinders, and we soon had it securely wired to the steam chest and cylinder proper. We then mixed up some asbestos cement and put a coating of it over the mill board, covering all the crevices. In replacing the pressure plate I had the copper gaskets removed and a fibrous gasket put in both places. When I put on the repaired cover, I had the two nuts over

the lugs faced to half their original thickness to allow the false cover to come down to its place. We took off the drain valves F and F′ and attached them to the cylinder at G and G′. After these repairs and changes were made, the pump was warmed up, the gaskets on the steam chest were followed up and then the pump was started, and it has run successfully ever since; at least the last report from the engineer was that everything is O. K. now.

Depew, N. Y. C. W. D.

A New License Law Suggestion. Abolish the "Special" License.

EDITOR THE PRACTICAL ENGINEER:

"How can water be delivered to a boiler by a small Dean pump placed beside the boiler from a well 40 feet below the surface?" in the question asked R. J. when up for examination and which he says he has asked a great many engineers and as yet has never had it answered.

There are a number of different ways that this can be done but I should like to ask: "Should such questions as this and the one asked J. R. in regard to finding the diameter of cylinders for a 2,000 horse power engine debar a man from getting a first-class license if unable to answer them?"

This only illustrates the fact that no one man knows all there is to be known about engineering matters or anything else and no doubt some who could answer the pump problem could not answer questions that might be easy for R. J., and perhaps R. J. could ask a few that the inspector himself could not answer.

The writer could design a number of engines of different cylinder diameters that would give approximately the same horse power and so could anyone who understands the matter, so what is the use of asking for the *required* diameter? A man who could answer the more important questions in regard to the care and management of a first-class plant would be a far safer person to have charge of that plant than one who could not answer but still holds the position on a "special" license at a lower wage. No doubt the practical questions would be asked by one who was really capable.

It is all right to test one's knowledge of engineering matters in general but not by using catch questions. Good, straight, honest questions are sufficient and do not confuse the applicant.

Now, the writer has long been of the opinion that each State should be divided into districts with one central point in each where examinations should be held at stated intervals and that there should be a board of examiners, consisting of five engineers, at each sitting. All first-class engineers in each State should be eligible for duty on this board and should be drawn about as men are drawn for jury duty and paid well while serving on the board of examiners. Let the inspector do the inspecting and not the examining and by this method there would be no chance to refuse to grant a license for personal reasons or to give one for the same reasons.

It seems to me that the better class of engineers should work for something along this line and place the profession up where it belongs; for surely there is no more honorable or responsible position, yet it is not so considered, just because there are too many "non-competents."

Last, but not least, make an effort to abolish the "special" license, which in case the applicant is not able to pass the required examination for a license of the first, second or third grade, as the case may be, he is still allowed to stay on the job and operate the plant at lower wage, of course, than would be asked by one who was really capable. This is an injustice to the capable man who holds a regular license and tends to lower the standing of the profession.

Richmond Furnace, Mass. E. C. A.

Banking Fires.

EDITOR THE PRACTICAL ENGINEER:

Just a few words, if I may, in reply to M. C. R., Carey, O., on "Banking and Cleaning Fires." He claims my ideas are the worst he ever heard of and goes on to say that as he has not had any marine experience, he won't attempt to tell me about marine work. The fact of the matter is, I have had but little stationary work and at the time I wrote my former article, I was watch engineer and saw 10 tubes blow out in boilers of the "Hogan" and "Sterling" types because they had been banked according to just such ideas as M. C. R. and C. D. advise.

Now I am a marine engineer and have had much experience with water tube boilers of the Roberts type, which are subjected to greater pressures than the aforesaid types and I have never had a leaky tube and have always, after banking my fires, fastened fire doors open and closed dampers so that there was just enough draft to keep the coal gases from backing out into the fire-room from the furnaces. With this method of procedure, I have always met with good results.

Furthermore, I will say once again, that the above method is required and we are compelled to do so by our United States inspectors and this applies to all types of marine boilers; Scotch, leg and water-tube. Today, I am engineer in charge of a boat having a triple-expansion engine and two Roberts water tube boilers and I will be greatly obliged if either C. D. or M. C. R. can *prove* to me that my theory is wrong. I will tell them what I believe causes most of those leaky tubes they are talking about.

Most stationary boilers are incased by brick which becomes red hot from firing. When they are blown down, the dampers, ash pit and furnace doors are left open and all the man-hole plates are knocked in as soon as possible, so as to hurry the cooling. Now what must be the result? Nothing but a sudden contraction of all boiler material, which causes most of the boiler troubles and not altogether the method of banking fires.

Ossining, N. Y. P. J.

How to Get Steam.

EDITOR THE PRACTICAL ENGINEER:

In a certain pumping station that I know of, they were having lots of trouble trying to get steam. No fireman could seem to hold it up, and yet they were working hard all the time. There was four five-foot boilers; they expected one man to do all the firing, with a coal passer to help on ashes and pass coal. They were willing to pay good money if they could get some one who could get lots of steam and yet not burn too much coal. They were continually changing firemen, sometimes four or five a week.

Finally, a friend of mine heard of the job and resolved to go after it. The chief told him to come around Wednesday afternoon and show what he could do, and if he proved satis-

factory he should have a steady job. Accordingly, my friend appeared on the scene of action at the appointed time, all ready for work. He was one of those long, lean, lank, cadaverous, knock-kneed, loose-jointed, lantern-jawed, hungry-looking specimens, but he was a most beautiful fireman—I never knew him to get stuck yet. "Now let's see if you can get any steam," said the engineer.

So my friend started in. Yanking open the fire doors, he immediately saw that the fires were all very thin and dirty, as the old fireman had collapsed into a chair, completely used up. My friend picked out all the clinkers that he could and rattled through most of the ashes with a hook. Then he began to gradually build up all the fires and yet not let the steam drop. He worked hard for about an hour, throwing in coal at a fearful rate, cracking the fires at frequent intervals, until finally he had four awful heavy, screeching hot crown-sheeters and the damper closed about all the time, and he was sitting down reading the paper.

The engineer came out and was thunderstruck. "I can't understand how you get so much steam," he said. "Well," said my friend, "look here." Going to one of the fires, he yanked open the door and there was a fearful heavy, hot fire, nearly up to the bottom sheet of the boiler. "That's the way I do it," he said. "Gracious, but you're a star; you beat them all," he observed.

My friend stayed on that job about four months and never had any trouble getting steam.

Allston, Mass. E. L. GRIGGS.

Chemical Testing of Storage Batteries.

EDITOR THE PRACTICAL ENGINEER:

In central stations, in large factories, and everywhere where storage batteries are used, the attendant, who is responsible for the plant, should be sure at all times that each cell is in the best condition of maintenance, which means that he must know if the electrolyte is pure, if the plates are working properly and if they are free from any slight coat of sulphate, which is very hard and resists the passage of the charging current. Therefore, the intelligent attendant is compelled to become a practical chemist. Sometimes in order to ascertain if any foreign organic matter or metallic salts are in the electrolyte, certain reagents must be used, and for that purpose, a test tube and some colored bottles in which to keep the reagents are necessary.

Now a concise description will be given of the several assays necessary to obtain the purity of the acid. Take in a test tube some quantity of the electrolyte and make the assay first to find traces of the chlorine and then the other impurities as follows:

I. To find the chlorides, use a few drops of nitrate of silver, which will give a white coagulated precipitate of chloride of silver. This precipitate is soluble in ammonia and is precipitated by nitric acid. When the precipitate is exposed to the light, it becomes violet in color.

II. To find the ferric salts, use red prussiate of potassium, which will give a dark azure solution. To find the ferrous salts, which are reddish, use a few drops of yellow prussiate of potassium and the solution will turn a dark Prussian blue, if there is any present. A few drops of the reagent are sufficient for the test.

III. To find copper traces, an azure precipitate is formed when potash is used or when ammonia is used, a light blue precipitate is formed which is soluble in excess of ammonia.

IV. To find traces of quicksilver, use a solution of hydrate of lime. If any is present, a black precipitate will be the result. If a piece of polished copper is immersed in the electrolyte, traces of mercury will be indicated by the copper becoming covered with a gray coloration.

V. To find other salts generally, test the solution with hydrate of lime and if any are present, a yellow precipitate will result.

VI. To find the nitrates, pour in a glass tube some of the electrolyte, to which add some chemically pure copper filings; then pour in a few drops of ferric sulphate. If nitrates are in the electrolyte, the color will change to a blackish-brown. If there is much chlorine present, make a test with gold by adding a small quantity of gold in sheets with some concentrated hydrochloric acid. If the gold dissolves, nitrates are present. The slightest quantity of dissolved gold can be revealed by adding a few drops of chloride of tin, which develops a red color.

The impurities in the electrolyte can also be caused by the bolts, nails, screws, straps, etc., especially when the battery is set up where these things are likely to fall in it, and to avoid any of these dangerous impurities, which will shorten the life and capacity of the cell, try to follow these rules:

a. Upon arrival of the battery from the manufacturer, make a test of the plates.

b. Make an accurate examination of the electrolyte and any electrolyte made with iron pyrites should be rejected. Use only the best electrolyte made with sulphuric acid and distilled water.

c. Don't use a mercury hydrometer to measure the density.

d. Use only absolutely pure distilled water.

e. Keep the required degree of concentration constant by the following means:

1. Add distilled water to diminish concentration.
2. Add electrolyte of 1400 Beaume to increase concentration.
3. Test the concentration of the electrolyte when the battery is completely charged.

f. Since the temperature is of great importance on the density of the electrolyte, note at what temperature every dose of water or acid is added to the electrolyte and then make compensation for the temperature or wait until it has reached 25 degrees C. or 77 degrees F.

Newark, N. J. C. P.

Method for Finding the Mean Effective Pressure and Diameter of Cylinder of a Compound Condensing Engine.

EDITOR THE PRACTICAL ENGINEER:

I have read with considerable interest the articles of the different engineers on examination questions. While I do not believe that the question in regard to the compound condensing engine is necessary or serves any useful purpose in determining a man's ability to safely operate a steam plant, I do think that it is made more of a bugbear than is really necessary.

In so far as the safe operation of a plant is concerned, a straight, practical examination is enough. The trouble with a question of this kind is that engineers pick it up, look at it, think it nonsense because they can't do it at once, and throw the paper down in disgust. They say they can't do it, think

they can't and the result is they can't do it.

This question of the compound engine, although a lengthy one, is not so difficult as it appears, and does not involve high mathematics, providing one understands the principles of the handling and working of steam and that every engineer should understand these principles cannot be disputed.

In a 2500 horse power cross-compound vertical condensing engine, the following data can be found:

Economical Boiler Pressure = 175 pounds absolute.
Economical Piston Speed = 800 feet per minute.
Diameter of High-Pressure Cylinder = 32 inches.
Diameter of Low-Pressure Cylinder = 52 inches.
Mean Effective Pressure in High-Pressure Cylinder = 60.65 pounds.
Mean Effective Pressure in Low-Pressure Cylinder = 25.2 pounds.
Terminal Pressure in High-Pressure Cylinder = 43.75 pounds.
Terminal Pressure in Low-Pressure Cylinder = 10.93 pounds.
Vacuum carried = 28 inches.

The above quantities are assumed or have been obtained as follows: The most economical boiler pressure, to my mind, will be 160 pounds gauge or 175 pounds absolute. In reference to the economical piston speed, I should say that a 4-foot stroke at 100 revolutions per minute would be about right, and since twice the stroke times the number of revolutions equal the piston speed, this would give 800 feet per minute piston speed.

In a well-designed compound engine, each cylinder should do half the work, or in this case 1250 horse power. The mean effective pressure can be found from the formula:

$$\text{M. E. P.} = \frac{\text{Init. Press.} \times (1 + \text{hyp. log. of ratio of expansion})}{\text{Ratio of Expansion}} - \text{Back press.}$$

and is the only one that approaches high mathematics. The cut-off can be taken at ¼, so that the ratio of expansion in the high-pressure cylinder is 4 and the logarithm of 4 is 1.3863. In the theoretical engine, the back pressure equals the terminal pressure and is obtained by dividing the number of expansions in the cylinder into the initial pressure, or $175 \div 4 = 43.75$ back pressure.

The mean effective pressure then is

$$\text{Mean Effective Pressure} = \frac{175 \times (1 + 1.3863)}{4} - 43.75$$
$$= 60.65 \text{ pounds}$$

The initial pressure for the low-pressure cylinder equals the terminal pressure of the high-pressure cylinder in a perfect engine, and since the engine is condensing to 28 inches vacuum, or one pound back pressure, the mean effective is obtained, assuming that there are also four expansions in this cylinder, as follows:

$$\text{Mean Effective Pressure} = \frac{43.75 \times (1 + 1.3863)}{4} - 1$$
$$= 25.2 \text{ pounds.}$$

To find the diameter of each cylinder, the well-known horse power formula is used or

$$\text{H. P.} = \frac{A \times \text{Mean Effective Pressure} \times \text{Piston Speed}}{33000}$$

or

$$A = \frac{33000 \text{ Horse Power}}{\text{Mean Effective Pressure} \times \text{Piston Speed}}$$

Substituting the proper values, the formula becomes

$$A = \frac{33000 \times 1250}{60.65 \times 800} = 850.16 \text{ square inches}$$

which is the area of the high-pressure cylinder required. The diameter is found by dividing the area by .7854 and extracting the square root, which gives a value near 33 inches, which is about the diameter required.

The diameter of the low-pressure cylinder is found in the same manner:

$$A = \frac{33000 \times 1250}{25.2 \times 800} = 2046.13 \text{ square inches}$$

from which the diameter is found to be about 51 inches. Instead of making the cylinders 33 and 51 inches in diameter, they would be made about 32 and 52 inches in diameter in practice as conforming to the usual sizes. So far we have experienced nothing to get scared at.

The drawing of the indicator cards is, of course, theoretical work, but this is not difficult, providing that indicator cards in general are understood.

New Bedford, Mass. F. W. C.

Cure for a Short-Stroking Pump.

EDITOR THE PRACTICAL ENGINEER:

In regard to L. L. Arnold's cure for pump troubles, in the September issue, I wish to say to L. L. A. that I think by this time he may have changed his mind as regards the washers as a cure. I took charge of a place, three years ago, where we have a Deane steam actuated condenser pump and I had all the troubles L. L. A. speaks about, but in my case the leather washers only acted as a cure for a very short while, then it was as bad as ever. It was so bad when I went there that the fireman was always listening for it, and if he could catch it when it stopped, he could, as a rule, get it started again without losing the vacuum.

Well, I had to do something to take that condenser off my mind, so I spent every spare minute that I had in watching that condenser, and I found that the valve stem jumped back just the same as if the valve had struck a piece of rubber or a spring; then the pump would short-stroke. I then put the leather washers on the head end; this gave me temporary relief. Then I tried adjusting the collars, but with the same result as L. L. A. had.

Here is what proved to be a positive cure, although some engineers will not like it, but an engineer often has to do things that theory teaches him he should not do. The packing used on the valve stem was a good soft packing. I took this packing out and put in its place a hard packing, and so long as I kept my stuffing-box tight with no leaks, it did not shut down, which in my case has been for over two years, but if you neglect to keep the packing on the valve stem tight, you can look for a hang-up and you might as well shut down.

Tuxedo Park, N. Y. J. M.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Horse Power of Water-Tube Boiler.

EDITOR THE PRACTICAL ENGINEER:

Will you be so kind as to figure the horse power of this boiler for me? I wish to have you figure it the same as the one on page 8, of the June number, by Chas. J. Mason. It is a water-tube boiler with two shells 36 inches diameter, 19 feet 3 inches long, with 171 lap-welded 3½-inch tubes, 16 feet long, grate surface 9 feet by 6 feet with 50 per cent. air space; working pressure 130 pounds.

Hartford, Conn. F. M.

As each type of water-tube boiler is built more or less upon different lines, the calculation of the heating surface for each type of boiler is an individual problem. In any case, however, the tube area gives the greatest and most efficient heating surface and is the most important in calculating the horse power.

In the above problem, the circumference of a 3½-inch tube is approximately 11 inches, and since there are 171 tubes, each 16 feet or 192 inches long, the total heating surface of the tubes is $11 \times 192 \times 171 = 361{,}152$ square inches. If $^1/_3$ the area of each of the drums be taken as available heating surface, this will equal $^1/_3 \times 3.1416 \times 36 \times 231 \times 2 = 17{,}415$ square inches, to which must be added whatever heating surface is available in the headers. This, however, may be neglected in making general calculations.

The total heating surface then is $361{,}152 + 17{,}415 = 378{,}567$ square inches and dividing by 144 gives 2,629 square feet. Allowing the usual rating of 10 square feet of heating surface per horse power for water-tube boilers gives 262.9 horse power as the capacity of the boiler.—[Ed.]

Horse Power of Fan.

EDITOR THE PRACTICAL ENGINEER:

Will you please tell me through your valuable journal what would be the horse power of a fan running 800 revolutions per minute and 1,000 revolutions per minute or what is the formula? The dimensions of the fan are, diameter over all 32 inches, number of vanes 8, diameter of vane at top 12 inches, at bottom, 4 inches, bore $1^3/_{16}$ inches.

Phila., Pa. W. S. B.

The following rule is given by Prof. Carpenter for finding the horse power required for a given fan or blower: "The delivered horse power required for a given fan or blower is equal to the fifth power of the diameter in feet, multiplied by the cube of the number of revolutions per second, divided by one million and multiplied by one of the following coefficients: For free delivery 30, for delivery against one ounce of pressure 20, for delivery against two ounces of pressure 10. If the speed be doubled, the horse power needed would increase 8 imes provided the resistance remains the same. It should be noted that the horse power as given by the above rule is that delivered to the fan and in reckoning the amount to be supplied it should be increased an amount sufficient to cover any loss by friction in the motor and transmission mechanism."

In the given problem, the wheel is 32 inches in diameter or 2.66 feet and in the first case is running 800 revolutions per minute or 13.3 revolutions per second. Assuming that the blower is working against one ounce pressure, the horse power equals:

$$\frac{(2.66)^5 \times (13.3)^3 \times 20}{1{,}000{,}000} = \frac{132.9 \times 2352.6 \times 20}{1{,}000{,}000}$$

$$= \frac{6{,}253{,}210}{1{,}000{,}000} = 6.25 \text{ horse power.}$$

The horse power required when the fan is running 1,000 revolutions per minute can be found in the same way.—[Ed.]

Equalizing Cut-Off. Renting Power. Heating of Bearing. Increasing Engine Capacity.

EDITOR THE PRACTICAL ENGINEER:

1. When setting the valves on a Corliss engine, it is usual to equalize the cut-off at one-fifth or a quarter of the stroke. Why is it done at that part of the stroke and cannot it be equalized at any other part of the stroke?

2. If you let power to other parties in another room or part of the factory, how could you tell what horse power to charge them with if you had no indicator?

3. If you increased the speed of an engine and the main bearing heated, what would be the cause and how would you remedy it, the engine to be in line and level, the boxes properly adjusted and the oil all right?

4. If you had to increase the boiler pressure from 80 to 120 pounds to keep the engine up to its regular speed as work was applied to it, and the engine kept taking steam to its full range of cut-off, what changes would you have to make on the engine if it were either a cross-compound condensing or a simple non-condensing engine?

5. When we say that an engine uses a pound of steam, does that pound of steam take one pound of water from the boiler?

6. When figuring the size of an air pump for a condensing engine, we say it takes 25 pounds of water to condense 1 pound of steam. When the steam is condensed, are there 26 pounds of water left?

Newburyport, Mass. J. T. M.

1. The cut-off is equalized at one quarter or one-fifth of the stroke because that is the usual economical running position of the valve gear. It can be equalized at any portion of the stroke.

2. If no indicator was available, the exact amount of power used could not be obtained unless an electric motor was used in that part of the factory, when a reading of the volts and amperes would give the power used.

It might be found approximately by watching the point of cut-off before and after the load was thrown on the engine and laying down indicator cards corresponding to same. The

difference in the area of the indicator cards should give a fair approximation of the amount of power used.

Another method often used is to limit the amount of power by allowing only a certain sized belt. For instance, if the belt was running 800 feet per minute and 5 horse power was all that you want the power user to consume, then use nothing larger than a 5-inch single belt; or if a certain sized belt is already in use, then charge according to the amount of power that the belt is capable of transmitting.

3. The cause would be the increase in speed of rubbing surface in feet per minute, between the shaft and bearing. It could be remedied, perhaps, by either using an oil of less viscosity or by using a bearing metal whose coefficient of friction is less than that used.

4. These conditions show that the engine is overloaded. If the engine was a simple non-condensing engine, the addition of a condenser would probably increase the power sufficiently to allow the steam to cut-off economically. In the case of the cross-compound condensing engine it would evidently be necessary to admit live steam into the low-pressure cylinder, although this would affect the economy. If the high-pressure cylinder was increased in diameter, this would also increase the horse power so that a proper cut-off could be obtained.

5. Not exactly, because every boiler primes, more or less, and the engine should never be credited with having used this amount of steam. If there is 4 per cent. moisture in the boiler steam, then it may be said that the boiler must use 1.04 pounds of water for every pound of steam the engine uses.

6. Certainly—26 pounds.—[Ed.]

Amount of Oil in Tank.

EDITOR THE PRACTICAL ENGINEER:

I have had a great deal to do with the installing and running of oil burning systems in the largest factories and steamers in the State and it often occurred to me that I would like to know a rule for figuring capacity of each inch of tank as the supply in the tank diminishes. We will say we have a tank 6 feet in diameter and 20 feet long. The engineer takes his measuring stick on starting in the morning and finds he has 70 inches of which equals a certain number of gallons. The following morning he finds he has 52 inches and so on each morning. Now, if his employer should come to him and say: "How much oil are we burning a day?" he would probably be able to tell him by figuring 2½ pounds of oil per horse power, but if his employer should say: "How much oil is in the tank?" he would probably have to say about ¾ or ½ full, or give a rough guess in gallons.

I have put this question to many engineers and to people well up in mathematics and they all said it was easy but when it came to doing it, they backed out. Of course, it must be understood that the tank is buried in the ground and is in a horizontal position.

San Francisco, Cal. M. L. S.

This problem can easily be worked out by the use of calculus but as very few persons understand the calculus, no attempt will be made to explain it along that line. Referring to the accompanying figure, which represents a tank in a horizontal position showing the level of the oil in a certain position, it can be seen that if the area of the segment of a circle be found for any level of the oil and that area multiplied by the length of the tank, the amount of oil which has been run out or the amount which is left in can easily be found. If this can be done for one level, it can be done for every level, so that the difference in the two calculations will give the amount of ail which has flowed out for a given diminution of the height of the oil level.

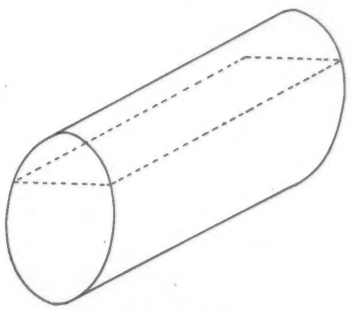
The easiest rule for finding the area of a segment is by means of the table of segments which follows:

Height	Area.	Height.	Area.	Height.	Area.	Height.	Area.
.005	.000471	.130	.059999	.255	.157891	.380	.273861
.01	.001329	.135	.063389	.260	.162263	.385	.278721
.015	.002438	.140	.066833	.265	.166663	.390	.283593
.02	.003749	.145	.070329	.270	.171090	.395	.288476
.025	.005231	.150	.073875	.275	.175542	.400	.293370
.03	.006866	.155	.077470	.280	.180020	.405	.298274
.035	.008638	.160	.081112	.285	.184522	.410	.303187
.04	.010538	.165	.084801	.290	.189048	.415	.308110
.045	.012555	.170	.088536	.295	.193597	.420	.313042
.05	.014681	.175	.092314	.300	.198168	.425	.317981
.055	.016912	.180	.096135	.305	.202762	.430	.322928
.06	.019339	.185	.099997	.310	.207376	.435	.327883
.065	.021660	.190	.103910	.315	.212011	.440	.332843
.07	.024168	.195	.107843	.320	.216666	.445	.337810
.075	.026761	.200	.111824	.325	.221341	.450	.342783
.08	.029435	.205	.115842	.330	.226034	.455	.347760
.085	.032186	.210	.119898	.335	.230745	.460	.352742
.09	.035012	.215	.123988	.340	.235473	.465	.357728
.095	.037909	.220	.128114	.345	.240219	.470	.362717
.10	.040875	.225	.132273	.350	.244980	.475	.367710
.105	.043908	.230	.136465	.355	.249758	.480	.372704
.110	.047006	.235	.140689	.360	.254551	.485	.377701
.115	.050165	.240	.144945	.365	.259358	.490	.382700
.120	.053385	.245	.149231	.370	.264179	.495	.387699
.125	.056664	.250	.153546	.375	.269014	.500	.392699

Rule for the use of table: Divide the height of the segment by the diameter, find the quotient in the column of heights, then get the corresponding area, multiply the same by the square of the diameter of the circle and the result is the required area of the segment.

If, therefore, as has been stated, the area of the segment is known, the cubical contents which has been emptied can be obtained by multiplying by the length.

Suppose the tank shows a height of 5½ feet of oil; then the height of the segment is 0.5 feet. Dividing by the diameter, which is 6 feet, gives a ratio of .0833, which by interpolation in the table gives .03108 as the area. Multiplying by the square of the diameter 36, gives $36 \times .03108 = 1.1188$ square feet as the area of the segment and multiplying by 20, the length of the tank, the contents emptied when the level is lowered one-half a foot is $1.1188 \times 20 = 22.376$ cubic feet



Contents of Tank

and since there are 7.48 gallons in one cubic foot, $22.376 \times 7.48 = 167.37$ gallons. As the tank originally held $.7854 \times 6^2 \times 20 \times 7.48 = 4229.79$ gallons, there still remains $4229.79 - 167.37 = 4062.42$ gallons.

For any other depth, the same method is followed. Suppose, as in the given problem, the amount of oil which has flowed

out between the level of 70 inches and 52 inches is wanted. In the first case, the height of the segment is 2 inches and in the second case 20 inches. In the first case, $2 \div 72$ gives .027 as the ratio which corresponds to an area of .00587, which when multiplied by 36 and again by 20, gives 4.226 cubic feet as the amount of space above the oil. In the second case, dividing 20 by 72 gives .277 as the ratio which corresponds to an area of .17733, which when multiplied by 36 and again by 20 gives 147.67 cubic feet of space above the oil. The difference between 147.67 and 4.226 or 143.45 is the number of cubic feet of oil which has been used. Multiplying by 7.48 gives the number of gallons, or 1073 gallons.

In this way, for any given tank, a table can be arranged by means of which the readings of the depth of oil will give directly the number of gallons in the tank.—[Ed.]

Lining up Engines.

EDITOR THE PRACTICAL ENGINEER:

Please tell me a good way to line up a Corliss engine to a generator, if the generator has been set already. What is a good way to tip a large fly-wheel up when it is lying on its side?

Oshkosh, Wis. F. P.

These are practical questions which depend upon local conditions and the kind of apparatus available. If the generator is set with the main shaft of the engine on it, care should be taken to see that it is perfectly level throughout the revolution. After the cylinder is in place, stretch a piano wire exactly through its centre. Revolve the crank until the crank-pin touches the wire and mark the point of contact. Then revolve the crank until it is at 90 degrees. When in this position drop a plumb-bob from the mark on the crank-pin and if the engine is set properly, the tip of the bob will exactly touch the centre of the wire. The fly-wheel can then be put in position by means of a block and tackle and suitable rigging.—[Ed.]

Stress on Boiler Seams. Connecting Boiler to Main.

EDITOR THE PRACTICAL ENGINEER:

Would you kindly answer the following questions and oblige a constant reader of your magazine?

1. Prove that the stress on a longitudinal seam is equal to twice the stress on a circumferential seam.

2. In connecting a boiler to a steam main that already has a full pressure on it, why is it advisable to have the boiler pressure 1 or 2 pounds less rather than 1 or 2 pounds more?

3. How would you determine whether the centre line of the crankpin is parallel to the centre line of the shaft?

Cincinnati, O. C. C. R.

1. According to the well-known law of hydrostatics, the pressure of steam in a closed vessel is exerted equally in all directions. In acting against the circumference of a cylinder, the pressure must therefore be regarded as radiating from the axis and exerting a uniform tensional strain throughout the enclosing shell.

The force tending to rupture the cylinder longitudinally is found by multiplying the diameter by the pressure on each unit surface and the force opposed to this pressure is the resistance of the material at the two opposite sides, or, representing the pressure in pounds per square inch by P, the diameter in inches by D, the length by L, the thickness of the material in inches by T, and its tensile strength by S, we have

$$PDL = 2TLS$$

as the equation representing the force tending to burst the boiler longitudinally and the strength of the boiler to resist that force. The thickness required can then be expressed

$$T = \frac{PD}{2S}$$

which shows that the strength of a cylindrical boiler to resist longitudinal rupture is in direct ratio to the thickness and strength of the plate or seam and is inversely proportional to the diameter and the pressure of steam.

The force tending to burst the boiler in a plane perpendicular to its axis or at its circumferential seam is equivalent to the area of the cylinder head multiplied by the pressure per square inch, or,

$$.7854\ PD^2$$

The resistance to this force is measured by the cross-section of the material around the circumference of the boiler and the strength is expressed by the formula, approximately,

$$3.1416\ TDS$$

so that when rupture is about to take place, we have

$$.7854\ PD^2 = 3.1416\ TDS$$

$$\text{or } T = \frac{PD}{4S}$$

which shows that the thickness necessary to prevent the boiler bursting around the circumferential seam need only be one-half of that necessary to prevent bursting along the longitudinal seam.

2. To prevent the sudden load being thrown on the boiler and to allow the conditions between the pressure in the main and the boiler to become equalized before the boiler begins to take its share of the load.

3. Level up the main shaft, then turn the crank through various angles of its revolution. If the crank pin is parallel to the shaft it should show exactly level in every part of its revolution.

Feed-Water Heaters. Inside and Outside Lap. Eccentricity.

EDITOR THE PRACTICAL ENGINEER:

Kindly answer the following questions:

1. What are the advantages and disadvantages of the open and closed feed-water heaters?

2. Does outside lap increase or retard compression?

3. What effect has inside lap on the time of admission and expansion?

4. What is the throw of the eccentric?

5. In what relation does the eccentric stand when the crank is on dead centre?

San Francisco, Cal. C. A. M.

1. The intense rivalry existing between the open and closed feed-water heater manufacturers almost precludes the discussion of this subject editorially. Every engineer also has some particular choice, either depending upon the condition of his plant or of his experience of the type of heater which he prefers. There are several points which may be said to be contested between the two types, among which may be mentioned safety from accident, purity of the feed water and back pressure in heater. The feed water entering the boiler, when the closed feed-water heater is used is pure water, while with

open heaters the purity of the water depends upon the internal construction and efficiency of the oil separators. With open heaters, however, the back pressure on the engine is practically nothing, while with closed heaters it may often be considerable. The open heater is not required to operate under pressure, hence it is generally considered to be safer from accident than the closed heater.

2. Outside lap of a D-slide valve lessens the lead, makes admission later and cut-off earlier.

3. Inside lap is used to prevent the expanding steam from being released before the end of the stroke and to close the exhaust port of the cylinder before the stroke is entirely completed.

4. The throw of the eccentric equals twice the radius of eccentricity and is equivalent to the travel of the valve.

5. The eccentric should be at 90 degrees plus the angle of advance if the valve is direct connected or at 90 degrees minus the angle of advance if the valve is connected to the eccentric through a reverse lever.—[Ed.]

Frustum of Pyramid.

EDITOR THE PRACTICAL ENGINEER:

Please explain through your paper, the method used in figuring the volume of a frustum of a pyramid. In the June issue I asked how many cubic feet there were in a piece of timber 15 feet long, 12 inches square at one end and 16 inches square on the other. By your method you get 35,520 cubic feet, which equals 20.55 cubic feet, but I get according to your method, 150,796 cubic inches. Please explain!

Ewo, Hawaiian Islands. J. S. P.

The cubical contents of the frustum of a pyramid are obtained by adding together the area of the two bases and a mean proportional between them and multiplying the sum by one-third of the altitude. The result is the volume required. The mean proportional between the bases is obtained by multiplying the area of the two bases together and extracting the square root. Therefore, according to above rule:

Area of one base $= 12 \times 12 = 144$ square inches
Area of other base $= 16 \times 16 = 256$ square inches
Mean proportional $= \sqrt{144 \times 256} = 192$ square inches

Sum of the three values $= 592$ square inches

The height of the frustum is 15 feet or 180 inches, so that one-third the height equals 60 inches, therefore,

Volume of Frustum $= 592 \times 60 = 35{,}520$ cubic inches
$= 35{,}520 \div 1728 = 20.55$ cubic feet

since there are 1728 cubic inches in a cubic foot.—[Ed.]

Weight of Coal. Cubic Feet per Ton.

EDITOR THE PRACTICAL ENGINEER:

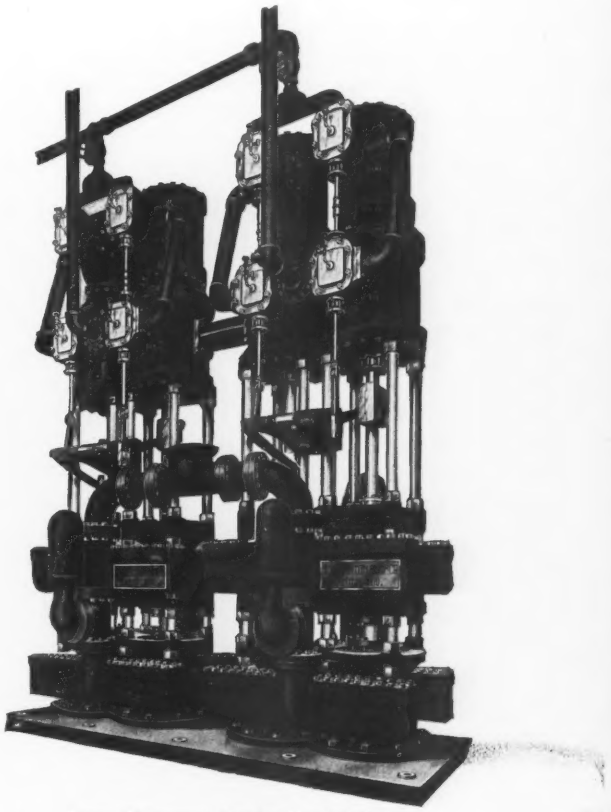
At a certain coaling dock, the buckets are 54 inches diameter and 40½ inches high. How much soft coal will the bucket hold? What is the weight of a cubic foot of soft coal and how many cubic feet are required to stow away one ton?

Detroit, Mich. F. N.

The weight of a cubic foot of soft coal varies from 50 to 55 pounds and it requires about 41 to 45 cubic feet to stow away a ton. The bucket of the above dimensions contains 53.66 cubic feet, so that the weight of coal that the bucket holds should approximate about 2,800 pounds.—[Ed.]

Large Hydraulic Pumps of the Duplex Vertical Type in use in Milwaukee.

In all our large cities, ground space has become so valuable that it is necessary to construct immense buildings of steel and concrete, towering into the air to a height of twenty-five stories, and buildings even rising to greater heights are in contemplation. These huge buildings often house as many people as an entire county in many parts of the United States. To make such a building of any use to the thousands who spend a large portion of the day there, the problem of quick transportation to the various floors is an important consideration.



Large Compound Duplex Vertical Pumps

One of the finest buildings in the Northwest is the sixteen-story Wells Building, in Milwaukee, in which the "Canton Pump Company, of Canton," Ohio, has lately installed a hydraulic elevator pump which we illustrate. This building has a complete power plant in its basement, and supplies heat, light and power, not only to the occupants of the Wells Building, but also to the Pabst Office, Pfister Hotel, Free Press, Windsor Hotel and Milwaukee Sentinel buildings.

This pump occupies a floor space of 6 x 12 feet. The base of the pump is one solid casting and weighs nearly five tons. As the illustration shows, there are two complete twin pumps identical in construction. Either pump can be operated independently of the other.

The pumps have 18″ high-pressure steam cylinders, 26″ low-pressure cylinders and 18″ stroke with 6″ plungers.

Each pump has a capacity of 250 gallons per minute, working against a pressure of 900 to 1,000 pounds per square inch, with 120 pounds steam pressure at the pump, and 120 pounds

water pressure at the suction and 150 pounds boiler pressure.

It will be seen that the pumps are of Duplex Compound type. The weight of the steam end is fourteen tons, and the weight of the water end and stretchers, about fourteen tons. Each pump is capable of exerting a pressure of 1,400 pounds to the square inch.

It is believed by the manufacturers that these are the largest hydraulic pumps of the Duplex Vertical type ever constructed.

This order was secured by the Canton Pump Company in competition with other manufacturers. When this order was placed, the manufacturers who failed to secure it made a prediction that the successful bidder would not be able to carry out its contract, but the word "fail" is not in the lexicon of the Canton Pump Company, and the pump was built and installed on time and is giving the purchasers entire satisfaction.

The Company would be pleased to correspond with engineers in regard to duplicates of this pump.

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The Newman Continuous Service Foot Valve and Suction Pipe Screen.

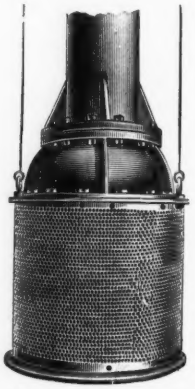
This foot valve is designed with a view of automatically preventing the trouble caused by the entry of refuse into the pipes of water system. It consists of the combination of a foot valve with a set of cylindrical screens, the smaller one of which is fixed to the foot valve proper and placed within the other. These screens are so arranged that the larger or outside one can be raised above the water line for cleansing without the necessity of disconnecting the valve or stopping any part of the plant.

Newman Foot Valve, showing Outer Screen Partly raised

All refuse such as leaves, fish, sticks, paper or rags, that lodge against the outer screen, can thus be easily removed after this screen has been brought to the surface of the water. The screen is raised by ropes or chains which are attached to screw eyes, shown in cut, and in most cases, excepting the very largest sies, one man can attend to the cleaning in a very few minutes.

When the outer screen is again lowered into position, the knives or scrapers, which are attached to it at top and bottom, scrape over the outer surface of the inner screen and thoroughly cleanse it.

The valve chest is provided with a hand hole plate and the capacity of the screens, as is required by underwriting associations, is made equal to ten times the capacity of the suction pipe in each case. The foot valve can be placed on bottom without danger of picking up pebbles as all water passes into



Newman Foot Valve showing Outer Screen in Normal Position

the valve at the sides, or by means of the suction pipe extension, the suction can be brought to within a few inches of the bottom plate of valve, thus permitting the successful operation in shallow water.

For further information address the Newman Manufacturing Co., 26 Cortlandt St., New York City.

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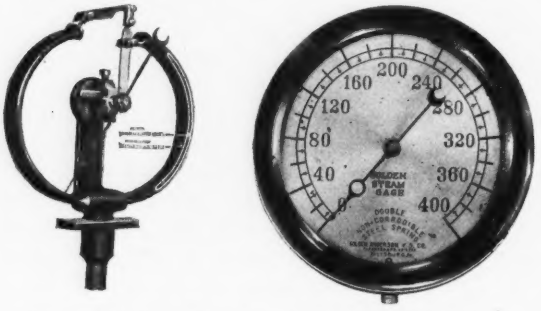
The Golden Non-Corrosive, Non-Setting Steam Gauge.

It is a well-known fact that steam gauges have a habit of not registering the right amount of pressure in the boiler owing to the set which often takes place in the metallic tube which regulates the pointer on the dial. If the pressure registered by the gauge is not correct, the engineer usually has no



The Golden Non-Corrosive, Non-Setting Steam Gauge

way of telling what the true pressure of his plant is, and should the pressure registered by the gauge be too low, a pressure in excess of that which should be carried is the result. This permanent set may take place after the gauge has been used only a short time, and if corrosion adds its destructive influence to the interior of the pressure tube, then there is no telling from time to time what pressure the steam gauge will register.

One of the most distinctive advances which have been made in the design of the steam gauge is embodied in the Golden

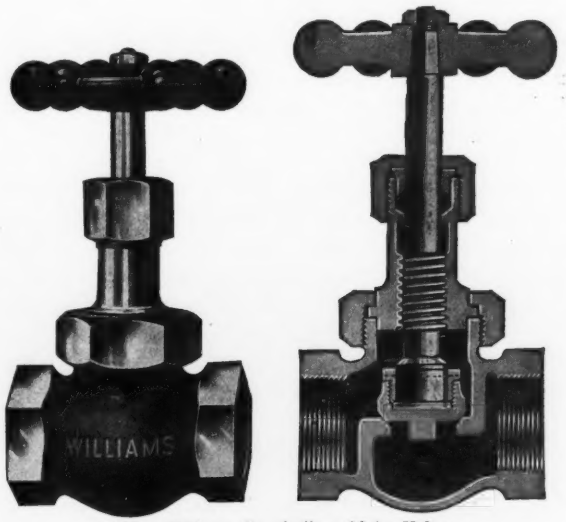
non-corrosive, non-setting steam gauge, shown in the accompanying illustration. The tube in this gauge is made of a double seamless brass and steel drawn tube. The seamless brass tube is within a seamless steel tube, and the combination results in a tube which is both non-corrodible and non-setting, and therefore it is not effective by vibration, shock or crystallization. The steel tube gives the necessary non-setting quality, and the interior brass tube protects it from corrosion.

As these tubes are tested at a pressure of 1000 pounds, it is claimed that under the lesser pressures used in practice, they will always be accurate and durable, and will always read the true pressure which is the function of a steam gauge. Any further information about these gauges may be had by addressing the manufacturers, The Golden-Anderson Valve Specialty Co., 107 Sixth St., Pittsburg, Pa.

Williams' Regrinding Valves.

The use of high pressures and temperature and the severe service which valves often undergo have brought about a demand for regrinding valves which require no extra discs and which can be repaired in a short time in any emergency.

The D. F. Williams Valve Co., of Cincinnati, O., are making a line of regrinding valves which not only answer the above requirements, but which are designed to give large lift of disc and large wearing surfaces, thus reducing friction of the wearing parts and insuring endurance.



The Williams Regrinding Globe Valve

The exterior and sectional views of a Williams' regrinding globe valve are shown in the accompanying illustrations. The method of construction consists of a hub which is firmly connected to the body by a union ring, which is screwed over and around the neck of the valve body, making a tight joint and adding to the strength of the valve. This arrangement prevents the threads from becoming corroded, as they are at all times protected from the steam. Another feature of this valve is that when the valve is wide open under full pressure of steam, the stem can be repacked without danger. The packing is facilitated by the removal of the hand wheel, which is held in place by lock nuts.

To regrind these valves, simply unscrew hub ring, remove trimmings from body, insert small wire in lock nut and through stem, place a little pulverized sand and oil on disc, replace the trimmings, allowing the bottom of the hub to glide in the neck of the body and regrind. This operation requires but a short time and when completed the valve is in as good condition as new.

These valves are made in two weights, medium and extra-heavy, with screwed or flanged ends. The valves are tested to 200 and 350 pounds, respectively, and are made in the globe, angle and cross type.

New Engineering Building at the University of Pennsylvania.

The new building for the Engineering Department of the University of Pennsylvania was formally dedicated on October 19th. The most noted engineers of this country and Europe were in attendance, and the building and equipment were pronounced by them to be the finest in the world. Erected at an expense of $1,000,000, it contains on its 128,000 square feet of floor space all the equipment that is necessary for the study of mechanical, electrical, civil and chemical engineering.

The building contains the machine shop, pattern shop, molding shop, forge shop, electrical laboratories, testing laboratories, hydraulic laboratories, mechanical laboratories, class rooms and drawing rooms. The mechanical laboratory is completely equipped with engines of all types and descriptions, including a Reeves compound engine, C. H. Wheeler condensers, Ames engine, Fleming engine, Westinghouse engine, Ingersoll-Sargent air compressor, Ericson hot-air engine, gas engines, oil engines, pumps of both the plunger and centrifugal type, pulsometer, hydraulic ram, dynamometers, water-wheels, calorimeters, testing machines, cold-storage room, hot-air room and all the necessary piping and experimental apparatus necessary for many experiments which are made with each piece of machinery.

The hydraulic laboratory is particularly complete, and contains various forms of deep-well pumps and air-lifts, weirs and tanks of various kinds for the proper performance of hydraulic experiments. The testing machine includes about a dozen different types, ranging in capacity from 30,000 to 600,000 pounds, of the tension, compression and torsion variety. The cement laboratory contains special testing machines for testing cements, mortars and bricks.

The entire building is now in use by the students, and the 600 men who, taking up the various engineering courses there, are assured of facilities which are unsurpassed for the study of engineering.

Reunion of Kensington Council.

On Saturday evening, October 13th, Kensington Council, No. 3, A. O. S. E., held a reunion at their new home, corner of York and Amber Sts., Philadelphia, and like all of the social occasions of this fine old council, it was a delightful affair. There were 150 guests present, jolly fellows, every one of them, and the Kensington boys kept things moving in the good old way for which Kensington has long been famous. Mr. Geo. W. Kennedy held the gavel and directed the affair in a manner that was pleasing to all, while President Donovan

moved about looking after the comfort of the guests and W. G. Worrall and several other brothers served the refreshments, which were delicious and abundant.

The speakers of the evening were Past Supreme Chief H. M. Trout, who was followed by Mr. John M. Lukens, Chief of the Bureau of Boiler Inspection, who urged the engineers of the city to be more careful about signing the applications for licenses of incompetent men. Following Mr. Lukens's speech, the guests were conducted to the second floor where, after a brief prayer by Past Supreme Chief Jas. Lightfoot, a sumptuous banquet was served. After the banquet there were short talks by Past Supreme Chief C. P. Williams, Geo. W.

The New Home of Kensington Council at York and Amber Sts. Building owned by the Council

Richardson, Jas. Lightfoot and J. C .McDowell. Then Deputy Supreme Chief Frank Connor made a forceful address advocating closer attention to the educational feature of the order, after which Charles Cook, who has been the Chief Instructor and the popular idol of Kensington Council for fifteen years, was introduced amid deafening applause. W. S. Price, of Atlantic City, made a brief speech in which he urged all present to attend the convention at Atlantic City next June. Mr. Mason, president of the Mason Coal Co., resplendent in white vest and tile, claimed to be a son-in-law of the council, having married the daughter of a member. Others who spoke were Mr. Lewis G. Schlehner, Chief Engineer of the Saquoit Silk Mills, and L. L. Rice, of THE PRACTICAL ENGINEER, after which Jack Armour entertained the crowd with songs, recitations and witty stories until a late hour.

Boiler Explosion Kills Five.

On Saturday afternoon, October 13th, a boiler exploded on the Government pump boat Slackwater, which was lying in the Ohio River, 20 miles below Pittsburg, killing five men and injuring six. The explosion occurred at 2.30 P. M., about one-half hour after the men had stopped work. The boat was used, in connection with a derrick boat, for repairing the Legionville dam, and was almost completely destroyed by the explosion. Fragments of timbers, boiler iron and debris were hurled through the air, and the bodies of the dead and injured were blown into the river. The derrick boat and some construction work, being done at the dam, were badly damaged. The exact cause of the explosion is not known, although one of the workmen who was not injured stated that he thought cold water had been run into the hot boiler.

Book Reviews.

American Stationary Engineering, by W. E. Crane. Size, 5½ x 8. 275 pages, 106 illustrations and several useful tables. Published by The Derry-Collard Company, New York City. Price, $2.00.

Starting in at the boiler room, this book takes the reader through the whole power plant, giving practical points of the various duties which are required of the engineer and describing the various methods for doing things which are constantly necessary around all power plants.

The chapter relating to the boiler room gives instructions as to firing, boiler feeding, boiler cleaning, boiler setting, boiler explosions and steam piping. The chapter on mason works gives various methods of constructing brick-work, laying foundations and building chimneys. The chapter on the engine room gives some pointers about lining up an engine, the advantage of different types of engines and the cause and remedy for hot bearings. The chapter on Corliss engines shows how the valves on this type of engine can be set and the chapter on valves is exceedingly brief in describing several forms of valves. Air pumps and condensers, cooling towers, tools for engine room, belting, oils, pumps, injectors and safety valves are then taken up with more or less thoroughness.

The book is well illustrated and plainly written, but the author shows his lack of ability in writing by continually expressing, with cheap phrases, his extremely narrow views on many subjects. For instance, in one place he says that the poppet valve has largely gone out of use but, like baggy trousers, it may occasionally come into fashion; in another place he says that the woman's method for removing clinkers is to put oyster shells in the fire next the brick, and so on; all of which may sound smart, but it is not the kind of information the average engineer is seeking.

Examination Questions and Answers for Marine and Stationary Engineers, by Calvin F. Swingle. Leather bound; pocket-book style. 360 pages, 212 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill.

This book gives the questions and answers to many of the principal details pertaining to the operation of both stationary and marine steam plants. In all, there are 800 questions and answers and each answer is a clear explanation of the question which is given.

Starting with questions on steam, heat, combustion and fuels, the other subjects taken up are the boiler, boiler construction, boiler settings and appurtenances, boiler operation, types of engines, condensers, air pumps, auxiliary machinery, the indicator and steam turbine.

To the engineer who contemplates taking an examination, the above book should prove very useful and instructive.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

Mr. Samuel S. Eveland, on behalf of the Standard Roller Bearing Company, of Philadelphia, of which he is Vice-President and General Manager, has purchased for that company, the entire plant and real estate of the Pennsylvania Iron Works Company, which adjoins their present property. By the purchase referred to, the Standard Roller Bearing Company have secured five factory buildings with a total of over 110,000 square feet of floor space, with real estate 1600 feet by 120 feet wide, all located on the Main Line of the Pennsylvania Railroad and connected with the property which they now occupy, making the total length of all their property over one-half mile, with an average width of 200 feet, covering 500,000 square feet of floor surface. The cash price paid for the property was nearly $250,000 and it will immediattely be equipped with a full line of machinery at an expense of over $200,000. When alterations are completed on the Pennsylvania Iron Works' property, over three thousand will be employed.

The year book of the Michigan College of Mines, located at Houghton, Michigan, has just been issued. This college, which occupies such a prominent position among the technical schools of this country, was established for the distinct purpose of training men to take an active part in the development of the mineral wealth of the State and nation. Situated as it is in the heart of the great copper mining region of Lake Superior, it has an environment that is particularly adapted to the study of mining engineering. The year book describes clearly the thorough course of instruction which is given to every student who enters its portals.

The Industrial Engineering Co., Drexel Bldg., Philadelphia, advise us that it has secured the contract for building a direct line of steam standard gauge railroad between Des Moines, Iowa, and Minneapolis, Minn., for the D. & N. I. Ry. Co. The object of the Industrial Engineering Co. is to employ expert engineering talent and business acumen to fix the value of an industrial process, enterprise or invention, and having decided that a given proposition is good, it takes it up and promotes it to a successful conclusion, sharing in the profits. A booklet which the company has, just issued, explains the company's proposition.

The Lubrication of Machinery Bearings, Grease *vs.* Oil, is interestingly discussed in a new pamphlet just issued by the Philadelphia Lubricator and Manufacturing Co., 1525 Land Title Bldg., Philadelphia. Those who want to read some arguments on lubrication that are different from the old old stories should send a postal card for copy of this pamphlet.

The New 1906 catalogue of Klipfel Mfg. Co., 76 W. Lake St., Chicago, has just been received. It describes their complete line of K. T. T. Steam Specialties, including pressure regulators, exhaust relief valves, condensation receiver and pump regulators, balanced valves, steam traps and several other specialties. It is forcefully illustrated and will be of special interest to those in charge of large plants. A copy will be mailed to any one mentioning "The Practical Engineer."

Mr. Harry P. Lesher has just accepted a position with Jenkins Bros. as salesman for Baltimore, Washington and Central Pennsylvania, to succeed Mr. William G. Le Compte, who has been promoted to the main store in New York.

The H. A. Rogers Company, 19 John Street, New York City, report a very busy season, with important orders from the Philippine Islands for railroad construction material and machine shop equipment.

James Bonar & Co., Inc., of Pittsburgh, Pa., are installing seven Bonar Automatic Oiling Systems for the Bethlehem Steel Co., at their new plant at South Bethlehem, Pa. They have also just completed a system for the McClintic-Marshall Construction Co., Pittsburgh, one for the Pittsburgh Plate Glass Co., Ford City, Pa., and one for the Ellsworth Coal Co., Ellsworth, Pa. Their systems are being used by such concerns as Carnegie Steel Co., Jones & Laughlin Steel Co., American Sheet and Tin Plate Co., U. S. Government, Pittsburgh Railways Co., and many others.

Their catalogue on Oil Filtration is interesting and gives full information regarding the systems. Address Frick Bldg., Pittsburg, Pa.

The Squires Steam Specialties, including steam traps, feed-water controller, reducing valve and pump governor, are forcefully illustrated and described in a fine new catalogue issued by The Strong Carlisle & Hammond Co., Cleveland, Ohio. A feature of this catalogue which distinguishes it from other modern advertising literature, is a number of wood engravings which show detail far better than the more generally used halftone.

E. M. Doyle & Co., manufacturers' agents, 323 Fulton Bldg., Pittsburg, Pa., though a young firm, are already commanding some large trade in mine and mill supplies, including pipe fittings, valves, packings and electrical supplies. Mr. Doyle is well known as a hustling salesman of engineers' supplies, and his associate, Mr. H. M. Wolfe, enjoys a large acquaintance among Pittsburg manufacturers, having been for several years connected with the Pittsburg office of *Iron Age*.

Eureka Association, No. 15 N. A. S. E., of Evansville, Ind., gave their second grand ball on Tuesday evening, Oct. 30, at Germania Hall, Evansville. Music by Foster's Orchestra. The committee in charge were Mr. Henry Randall, Mr. Chas. Bredenkamp and Wm. Lohoff.

The Wooley Smokeless Furnace is illustrated in a new catalogue just issued by the Wooley Smokeless Furnace Co., Fifth and Liberty Streets, Pittsburg, Pa. The purpose of this furnace is to improve combustion, thus preventing smoke by consuming all the gases and giving greatly increased efficiency. The new catalogue shows the manner of application to various types of boilers and describes the construction and operation of the furnace in detail. A copy of the catalogue will be mailed to any one mentioning THE PRACTICAL ENGINEER.

Mr. F. E. Emery has accepted a position as traveling representative for the Holmes Metallic Packing Co., of Wiles-Barre, Pa, Mr. Emery is an engineer of ability, and is well known and popular with engineers. His success is assured.

WANTED—Good Steam Specialty Salesmen in every city to handle a high grade appliance for which there is a live and growing demand. Large profits. Address CORPORATION, care The Practical Engineer.

WANTED—Salesmen and Manufacturers' Agents, traveling amongst engineers and superintendents, to sell IDEAL METALLIC PACKING for steam, air and ammonia. Good commission. Ideal Metallic Packing Co., Box 52, St. Paul Minn.

WANTED—Experienced Engine Erectors for permanent employment in one of the largest engine manufacturing concerns in the country. Address Box 6, care of Practical Engineer.

One setting only is required on the RUNNERLESS SLIDE RULE.

To solve any of the following three proportions: — a:b::c:d, a:b::c²:d, a²:b::c²:d. New Method of Operating Explained in Booklet. F. F. Nickel, 27 Winaus St., East Orange, N. J.

"POLARITY INDICATOR, 25 CENTS. Works on any voltage; satisfaction guaranteed. Postpaid to any address on receipt of price (coin). J. H. Gravell, 1005 Drexel Bldg., Phila., Pa."

WANTED—Engineers and Mechanics to make big money selling O. K. Hand Soap. A 10 cent can will instantly remove more dirt and stains from the hands than 4 cakes of any soap made, and it will not injure the most delicate skin. Sample free. O. K. HAND SOAP CO., 570 Columbus Ave., Boston, Mass.

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address FRANCE PACKING Co., Tacony, Phila., Pa.

PATENTS Watson E. Coleman, Patent Attorney, Washington, D. C. Advice free. Terms low. Highest ref.

PATENTS Procured ISEDORE S. PRENNER, E.E. Attorney-at-Law, Solicitor of Patents, Consulting Engineer, Law, Patent and Engineering Cases. Room 1108 Betz Building, Philadelphia.

PATENTS PROMPTLY SECURED. Highest references from prominent manufacturers. Write for Inventors' Hand-Book, SHEPHERD & PARKER, 186 Deitz Building, Washington, D. C.

Flexible Metallic Tubing is an all metal hose for steam, air, oil, etc., up to 3000 pounds pressure. It is made in sizes from ⅛ to 10 inches diameter, and of either steel or copper. Especially fitted lengths in ½ and ¾-inch for blowing boilers. For circulars and prices address Pennsylvania Flexible Metallic Tubing Co., 1305 Arch Street, Philadelphia.

Monarch Metallic Ring Packing for ammonia compressors is described in a circular issued by J. B. Hackett, Temple Court, New York City.

Mr. A. D. Hamilton, 159 Henderson Street, Allegheny, Pa., has been appointed manager in the Pittsburg district for the Buckeye Boiler Skimmer Co., of Toledo, Ohio. Mr. Hamilton is an engineer of ability, enjoying a large acquaintance among engineers of Western Pennsylvania, Ohio and West Virginia, in which territory there are many Buckeye Skimmers in successful operation.

An illustrated circular describing the Lombard-Replogle Water Wheel Governors has been received from The Lombard-Replogle Engineering Co., Akron, Ohio.

Ever see a split steel pulley? Perhaps not. They're new, and possess some advantages that other pulleys do not, for instance, they can be applied without stripping the shaft; that's pretty good, isn't it? But that isn't all, the rest is told in a new folder just issued by the manufacturer which shows some good cuts, gives prices, sizes, etc. If you wish one, address Latshaw Pressed Steel Co., Pittsburg, Pa.

The second edition of the general catalogue of the Cookson Steam Specialties has just been issued by the D. T. Williams Valve Company, of Cincinnati, Ohio. It contains fine illustrations of both the Cookson Steam Trap, for high and low pressure; and the Cookson vertical and horizontal steam and oil separators. Any one interested in this kind of power-plant equipment, will do well to write for a copy of the catalogue.

The General Specialty Co., of 75 Carroll Street, Buffalo, N. Y., have received the following letter from the Chief Engineer of the State Penitentiary, Walla Walla, Wash: "Replying to your letters relative to your flue cleaner, I wish to say that the State already owns one of your devices, which is used for the various State institutions, and at the present time I hardly think we would be justified in buying another. I will add, however, that your scale remover is the most complete success I have yet met with. Wm. M. Quinn, Chief Engineer."

A large illustrated circular just issued by the Golden-Anderson Valve Specialty Co., 107 Sixth Street, Pittsburg, Pa., shows an interesting line of power-plant specialties, among which is the new Golden "Clean Seat" Valve, in which the bottom of the disc is hollow, being held in position by solid cast eccentric lugs, around which a slot is cut the entire outside diameter. As the slot comes level with the seat when closing, the steam, water or air, blows directly across the seat and disc, cleaning them of all sediment or obstruction of any kind that would be likely to do harm. This valve seems to possess some other good features; the bonnet joint and its appearance of great strength are both noticeable. The same principle for cleaning the seat is used in the Golden blow off valve. The Golden steam gauge, which is mentioned in another column of this issue, and several other specialties make this circular of more than ordinary value. A postal card will bring you one.

Mr. J. B. Hackett, 5-7 Beekman Street, New York, has accepted the selling agency for The Unique Turbine Exhaust Head and Draft Generator, which is indeed a unique combination, all of which is described in a catalogue which Mr. Hackett will send to any of our readers upon request. A smoke-consuming apparatus can also be incorporated with it, and Mr. Hackett informs us that the whole equipment has proven a splendid success, especially in wood working establishments or other places where they burn shavings or wood.

The Canton Steam Pump Co., Canton, Ohio, have published a handsome new catalogue, which is printed in colors and handsomely illustrated with numerous half-tone cuts of Canton pumps for every kind of pump service. A combination picture on page 34 gives a perfect sectional view of a duplex pump and shows each part separately down to the bolts and nuts and giving the name of each part. It also contains several pages of valuable pump data, useful to any one contemplating the purchase of steam pumps for any kind of service.

The Keystone Lubricating Co., of Philadelphia, have received a letter under date of July 30, 1906, from Mr. Chas. Gausman, Chief Engineer of Steamer "Chas Merion," Cairo, Ill., as follows:

"Gentlemen:—The sample of Keystone Grease, consisting of Nos. 1-2-3-6 densities, sent me some time ago, have been given a thorough test. I find that they are all and more than you represent them to be.

"I have had various chances to use many kinds of oils and greases during my eighteen years' experience as Assistant and finally Chief Engineer on river steamers, as well as on stationary machinery, and never during that time have I found a lubricant which can compare with your No. 1 and No. 2 densities.

"One cup of Keystone Grease, either No. 1 or No. 2 densities, will go further and lubricate better than four to five cups of any other grease that I have ever used.

"Your fluid grease or No. 6 density is extra good for any purpose where a liquid oil is required—especially for cutting threads on bolts and gas pipe.

"I advise any engineer who is troubled with hot bearings to use the 'Keystone' products—his troubles will then be over."

The Pittsburgh Feed Water Heater Co., 716 Frick Bldg., Pittsburgh, Pa., report the following recent sales of heaters: Monarch Coal Co., East Brady, Pa., 250 H. P.; Rosehill Electric Light Co., Turtle Creek, Pa., 500 H. P.; Midland Coal & Coke Co., Hackers' Junction, W. Va., 400 H. P.; Vinton Colliery Co., Vintondale, Pa., 2000 H. P.; Tecumseh Water Works, Tecumseh, O. T., 300 H. P.; Lockhart Iron & Steel Co., McKees Rocks, Pa., 1500 H. P.; Cambria Forge Co., Johnstown, Pa., 300 H. P.; Consolidation Coal Co., Baltimore, Md., 200 H. P.; Bennett Engineering & Steam Specialty Co., Cleveland Ohio, 150 H. P.; Fairmount Coal Co., land Ohio, 150 H. P.; Fairmont Coal Co., Baltimore, Md., 250 H. P.; Philip Carey Mfg. Co., Lockland, O., 1500 H. P.; East Brady Woolen Co., East Brady, Pa., 250 H. P.; American Axe & Tool Co., Glassport, Pa., 3000 H. P.; Belle Vernon Water Co., Belle Vernon, Pa., 150 H. P.; Darling Milling Co., Fremont, Mich., 150 H. P.; North American Steel Co., Belington, W. Va., 1000 H. P.

GRAPHO
SOMETHING NEW
A new preparation for enriching oils.
Will suspend in oil.
No more Hot Journals.
Engineers who have tried same claim it to be the best yet.
SEND FOR SAMPLE
A trial will convince you
AGENTS WANTED
GRAPHO MFG. CO.
Cor. Frank and Commercial Sts.
ROCHESTER, N. Y.

Kieley & Mueller, the well-known manufacturers of steam, water and air specialties, announce the following to be their up-to-date line of guaranteed specialties: Reducing Valves for all purposes, Back Pressure Valves for all purposes, Atmospheric Relief Valves, Steam Traps for all purposes, Damper Regulators, Hot Water Temperature Controllers, Steam Separators, Grease Extractors, Pump Regulators, Water Pressure Regulators, Water Feeders, High Pressure Boiler Feeders, Feed Water Regulators, Grease and Oil Traps, Water Arches, Emergency Valves, Low Water Alarms, High and Low Water Alarms, Strainer Connections, Drip Tank Controllers, Float Valves, Tank Pump Controllers, Pump Governors and Receivers, Combination Muffler and Grease Extractor Tanks, Receivers, Pump Governors, Pump and Feed Water Heater, Feed Water Heaters, Grease Extractor and Purifier, Waste Heat Utilizers, etc.

Main Office at 34 West 13th Street, New York City; Branch Offices agencies throughout the country. Circular matter and catalogues to be had on application.

Mr. Geo. D. Rollins, general manager of the Holmes Metallic Packing Co., Wilkes-Barre, Pa., has returned from an extended Western trip with several large orders. One order totals 229 inches for rods rounding from 8 to 16 inches in diameter. Mr. Rollins reports business brisk; their factory has been running night and day for several weeks.

The Atlas Specialty Co., 72 Tracy Street, Buffalo, N. Y., are offering a twenty-year gold watch free with each initial purchase of sixty pounds of their X-L-O Belt Dressing.

The O. K. Hand Soap Co., 570 Columbus Avenue, Boston, Mass., are advertising for engineer agents to sell their hand soap. They offer to send a sample free to any one interested.

"Unit Type" Oil Filters

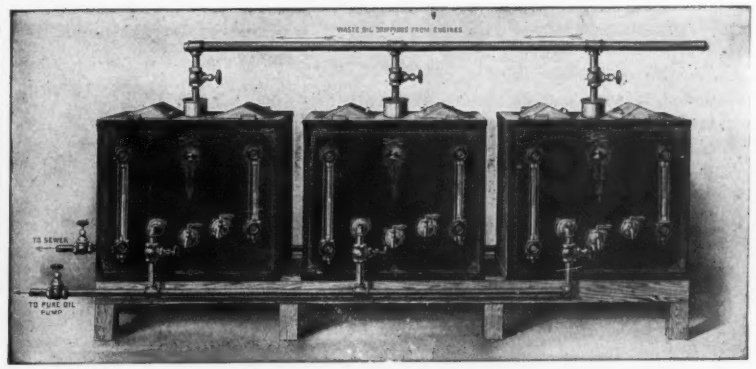
PATENTED

are the result of 15 years' experience in making over 20,000 Oil Filters, and are the most modern filters on the market today. Our filters have a world-wide reputation, are used in 29 countries, and have been officially adopted by 10 governments. Our "Unit" Filter is 42 inches long, 3 feet high and 28 inches wide, with a filtering capacity of from 200 to 250 gallons in 24 hours. Filter can be used with or without an oiling system, and is so constructed that **any kind** of filtering material can be used and is **guaranteed** to clean and purify the thinnest as well as the heaviest grades of lubricating oil—such as cylinder, crank case, lard oil, etc. Any number of "Units" can be operated together or separately, as desired. Whenever the power plant increases, additional "Units" can be installed and connected with those in operation; thus the oiling system increases in proportion to the growth of the plant.

The Philadelphia Rapid Transit Company, operating eight of the most modern power plants in the United States, after examining all of the leading makes of filters on the market today, selected 6 of our "Units" for use in connection with 33,000 h. p. steam turbines installed in their new plant. After making a chemical analysis of the filtered oil they ordered 4, later on 6 more and now they place an order with us for 4 making 20 Units in use in 4 power plants. This tells its own story.

Just a Few "Unit" Users

Philadelphia Rapid Transit Co., Philadelphia, Pa. (20)
Ashland Steel Co., Ashland, Ky. (3)
Calumet & Hecla Mining Co., Calumet, Mich. (7)
Rockefeller Bldg., Cleveland, Ohio (2)
Rome Brass & Copper Co., Rome, N. Y. (2)
Dayton Lighting Co., Dayton, Ohio (2)
Jacob Ruppert Brewing Co., New York, N. Y. (2)
Mutual Life Insurance Co., New York, N. Y. (2)
Alabama Portland Cement Co., Demopolis, Ala.
Niagara Construction Co., Niagara Falls, N. Y.
Olympia Cotton Mills, Columbia, S. C.
Carnegie Natural Gas Co., Waynesburg, Pa.
South Bend & Southern Michigan Ry. Co., Scottdale, Mich.
Goodyear Tire & Rubber Co., Akron, Ohio.
Baltimore Refrigerating & Heating Co., Baltimore, Md.
Dartmouth Mfg. Corporation, New Bedford, Mass.
Indiana Railway Co., South Bend, Ind.
Manual Training High School, Kansas City, Mo.
Waterloo & Cedar Falls Gas & Electric Light Co., Waterloo, Ia.
Youngstown Sheet & Tube Co., Alice Furnace, Sharpsville, Pa.
Somerset Coal Co., Pine Hill, Pa.
Athens Electric Railway Co., Athens, Ga.
The John Bromley's Lace Mill, Philadelphia, Pa.
Headley Chocolate Co., Baltimore, Md.
Singer Manufacturing Co., St. Johns, Can.
St. Louis Portland Cement Co., St. Louis, Mo.
The Cleveland Frog & Crossing Co., Cleveland, Ohio.
Post Office Department, Washington, D. C.
American Brass Co., Ansonia, Conn.
Worcester Consolidated Street R. R. Co., Worcester, Mass.
Baldwin Locomotive Works, Philadelphia, Pa.
Peerless Rubber Mfg. Co., New Durham, N. J.
General Chemical Co., Camden, N. J.
Illinois Steel Co., Chicago, Ill. (4)
Maryland Steel Co., Sparrow's Point, Md. (6)
Iron & Steel Works, Monterey, Mexico.
Bahia Tramway Co., Bahia, Brazil.



THREE "UNITS" CONNECTED AND OPERATED AS ONE FILTER

The Calumet and Hecla Copper Mining Co., the largest copper mining corporation in the world, have recently, after careful examination, placed their order with us for 3 "Units" for their new power plant—a power house embodying the latest and most improved machinery. They have recently ordered 4 more, making a battery of 7 in one plant. It might be well to add that this firm has purchased 25 oil filters from us during the last 12 years, which speaks for itself.

Another notable equipment was an installation of 2 "Units" for the new office building recently erected in Cleveland, Ohio, by John D. Rockefeller of the Standard Oil Co. (This firm has 75 of our filters in use in their own pumping stations.)

The Baldwin Locomotive Works, known throughout the entire world as users of the latest and most improved machinery, have just ordered one "Unit" to be installed in their new power house.

Every engineer, mechanical engineer, consulting engineer—in fact, anyone coming in contact with power plants, should have a copy of our new 64-page catalog—the finest issued by an oil filter firm. It contains a full description of our "Unit" Filter, also the "Cross" American and Warden Oil Filters and the Burt and Standard Exhaust Heads and the Burt Ventilator.

The Burt Mfg. Co. Largest Manufacturers of Oil Filters in the World. 204 Main Street, AKRON, OHIO, U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors

Carson's High Pressure Piston Packing is made of selected, long fibre asbestos, tightly braided and lubricated with a special lubricant, which withstands the action of steam at high temperatures and prevents it injuring the rod. It is made in sizes from ¼ to 2½ inches. A sample will be sent to any one who wants to see what it is like. Address A. W. Chesterton & Co., 64 India Street, Boston, Mass.

A free sample can of "Ambest" Metallic Packing for trial is offered by the Canfield Mfg. Co., 116 West Lehigh Avenue, Philadelphia, to any engineer or steam user.

This offer appeared in an advertisement on page 48 of our October number, and the company received so many orders and requests for sample cans that they have repeated the offer again in this issue.

Those who are not familiar with "Ambest" should send for a sample and give it a trial.

The National Pipe Bending Co., New Haven, Conn., have just shipped to the Cos Cob Electric power station of the New York, New Haven and Hartford Railroad Company an 8,000 horsepower National Feed Water Heater. This heater is the largest ever made by The National Pipe Bending Company.

The heater has 42 coils of 1⅝ inch outside diameter copper tube, No. 14 B. W. G. These coils are expanded into a header at each end of the heater. The feed water is passed into one header, through the coils, and out through the other header to the boilers, and the water is heated to 200 degrees and over. The dimensions are as follows: Diameter 84⅛ inches, height 11 feet 2 inches. The heater is designed to set vertical.

The electric power station at Cos Cob is being constructed by Westinghouse, Church, Kerr & Co., of New York, who are the designers and builders of the plant. The plant will commence running about the first of November, and will supply power for the electric line from Stamford to New York.

If any of our readers failed to take advantage of the offer made by the Boston Incandescent Lamp Co., of Danvers, Mass., in the September number of THE PRACTICAL ENGINEER, they will do well to order a trial package of the Boston Renewed Lamps at 12 cents, for these lamps have a splendid reputation for efficiency and the saving is well worth considering.

Clement Restine & Co., Philadelphia, have purchased two more large buildings adjoining their former location on North Second Street, which runs their street numbers from 133 to 139, and doubles their capacity. The offices have been enlarged to twice their former size and handsomely furnished with the most modern equipment for the facilitation of business. The growth of this concern from a very small beginning only a few years ago has been remarkable.

A small catalogue has just been received from Union Seam Pump Co., Battle Creek, Mich. It contains some fifty half-tone illustrations of the Great Burnham Steam and Power Pumps. It also contains a few pages of good pump talk; not the long-winded milk and water kind, but the kind that aims to give a pound of information with each ounce of type—the kind that is likely to make some engineers look at pumps in a different light. Write for a copy before the edition is exhausted.

The Michigan Lubricator Company, of Detroit, Mich., has just issued a catalogue of 108 pages illustrating and describing their complete line of Lubricators, Oil Cups, Oil Pumps, Grease Cups and other trimmings for steam engines, gas and gasoline engines, air compressors, boilers, etc. This handsome book will be mailed to anyone interested free of charge. Mention "The Practical Engineer."

The American Boiler Economy Co., 1001 Chestnut St., Philadelphia, have received a letter from Mr. Samuel T. Brady, chief engineer for the Corona Kid Co., Bristol, Pa., as follows:

"I would report that the second order of Copes Automatic Boiler Feed Regulators and Pump Governors received from you have now been installed on the two Berry boilers and the pump supplying them, and are working perfectly. The regulators placed on our Coatesville boilers several months ago are also giving perfect satisfaction.

"Since the regulators have been in service we have been able to maintain a fixed water level in the boilers. This has not only given us a more uniform system of firing and a marked saving of coal, but we also find that we are securing a much dryer and better circulation in the heating system, making the regulator a very valuable device in the leather business, because of the large number of drying rooms and baking ovens to be operated."

A 48-page pamphlet describing various types of horizontal and vertical ammonia compression refrigerating machines and equipment for ice plants, breweries, packing houses, etc., has just been issued by the De La Vergne Machine Co., foot of E. 138th St., New York. The book is illustrated by many fine half-tones, a feature of these being the clever and artistic arrangement of composite views of plants installed in various parts of the world.

One of the chief advantages claimed for P. P. P. Packing is that it varies its pressure on the rod with the varying steam pressure in the cylinder. This is accomplished by the sliding wedge which keeps the packing just steam tight, no more, and only during that short second when the pressure in the cylinder is greatest, is there any excessive friction. During the remainder of the piston stroke, the wedge, it is claimed, allows the pressure to relax, thus friction is greatly reduced and both rod and packing presersed from wear. The new booklet of P. P. P. should be read by engineers having packing troubles. A postal card to the Quaker City Rubber Co., Philadelphia, will bring you one.

Western Tube Co., Wewanee, Ill., have issued a little booklet regarding a new discovery in bronze mixture, known as "High-Duty" metal. According to the booklet, this metal shows a loss in efficiency when subjected to high temperatures of only 5.6 per cent. while ordinary mixtures show a loss in efficiency four to five hundred per cent. greater, when subjected to the same conditions, and even the Famed Government mixture, it is claimed, shows a loss in efficiency of some 50 per cent. over "High-Duty" metal under the same conditions. This marks a distinct advance in bronze compositions and the booklet it well worth reading. We presume that a postal card will bring a copy of it to any readers of "The Practical Engineer."

A NEW BOOK ON

Mechanical Draft

by J. H Kinealy, M. Am. Soc. M. E.

Mr. Kinealy is a recognized authority on mechanical draft and in this book has covered the subject thoroughly.

He has had in mind the practicing engineer who is called upon to design power plants, and who must therefore decide when it best to use some form of mechanical draft.

There are 156 pages, 13 plates, etc.

Price, Cloth, $2,00, post paid

Spon & Chamberlain

123 P. E. Liberty St., New York

The Smith Pipe Clamp

Stops The Leak Every Time

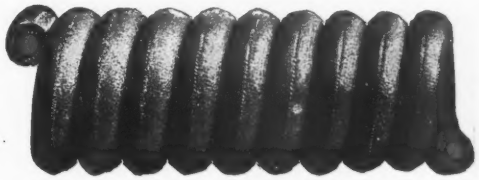
A complete set for every size of pipe in your plant will save many a dollar. Quickly applied while pressure is on the pipe WE GUARANTEE TO STOP THE LEAK. Steel or brass, all sizes, ¾-inch to 20-inch. No trouble to send further information.

W. CLIFFORD SMITH

138 N. SIXTH STREET

PHILA., PA., U. S. A.

PEERLESS PISTON and VALVE ROD PACKING



Made with Round Core of the celebrated Rainbow Packing Compound, surrounded by layers of soft, loosely woven duck, thoroughly impregnated with finest grade of plumbago lubricating material.

WILL HOLD 400 lbs. OF STEAM.

WE MAKE THE PEERLESS PISTON AND VALVE ROD PACKING ROUND, SQUARE, SPIRAL AND IN RINGS.

WE CONFIDENTLY BELIEVE THIS PACKING TO BE FAR SUPERIOR TO ANY PISTON AND VALVE ROD PACKING ON THE MARKET.

DON'T WAIT! *ORDER A BOX TO-DAY!*

SUCCESS SEMI-METALLIC DIAGONAL EXPANSION SPIRAL PACKING RAINBOW CORE

Patented Oct. 31, 1899.

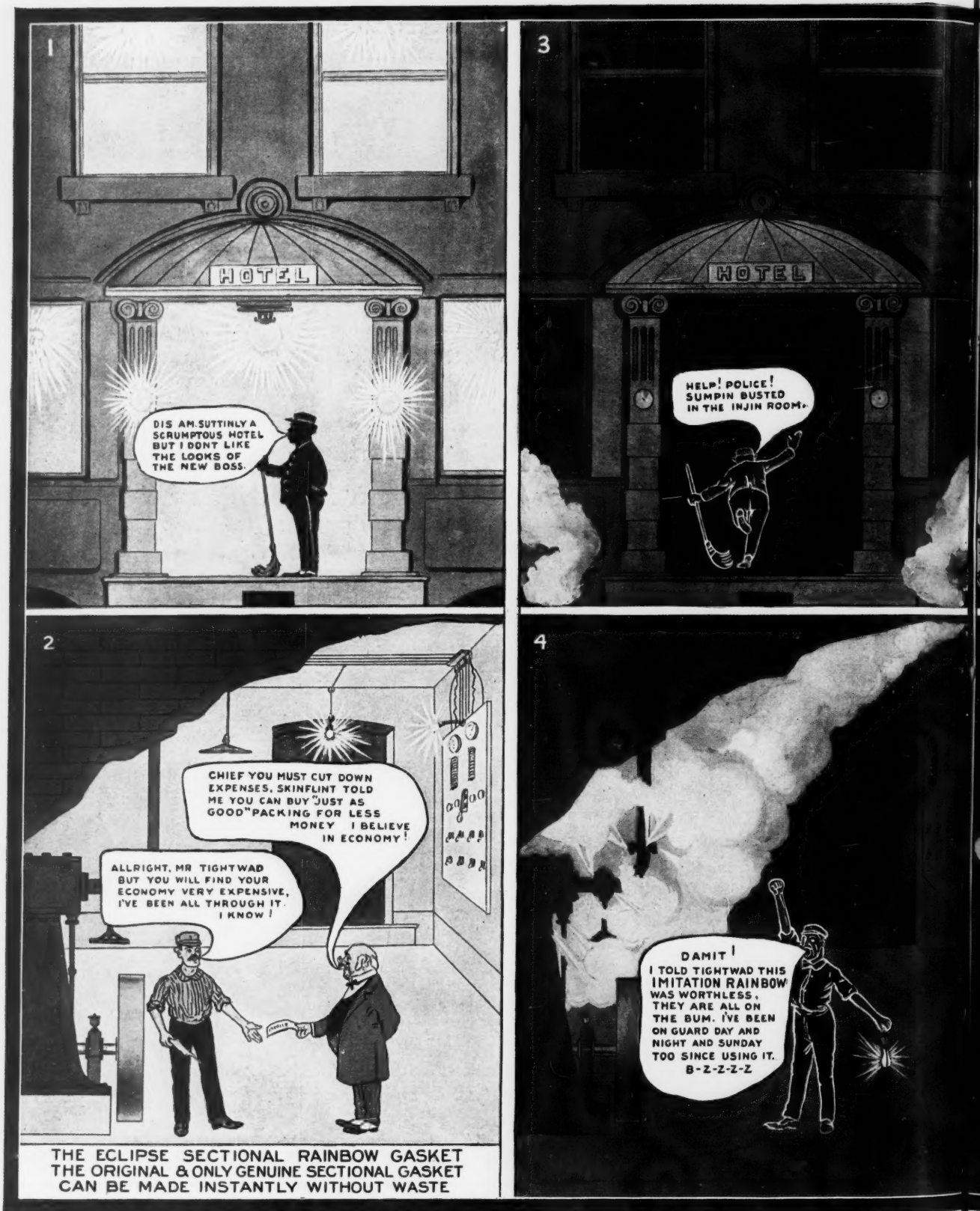
The "Success" is the "Best" Combination Packing yet devised, both as regards principle of Construction and Material used, for Steam, (low or high pressure), for Water, (hot or cold), and for Ammonia Machines.

The Spiral form is the correct shape of all Modern Constructed Packing, and readily and quickly conforms to the ring shape so greatly desired. The Soft Metal used is a Wear Resister; it is an Automatic Expander under heat conditions; it will not scratch or cut the rod under any conditions.

Manufactured, Patented and Copyrighted Exclusively by

Peerless Rubber Manufacturing Co.

16 Warren Street, New York


1
HOTEL
DIS AM. SUTTINLY A SCRUMPTOUS HOTEL BUT I DONT LIKE THE LOOKS OF THE NEW BOSS.
2
CHIEF YOU MUST CUT DOWN EXPENSES, SKINFLINT TOLD ME YOU CAN BUY "JUST AS GOOD" PACKING FOR LESS MONEY I BELIEVE IN ECONOMY!
ALLRIGHT, MR TIGHTWAD BUT YOU WILL FIND YOUR ECONOMY VERY EXPENSIVE, I'VE BEEN ALL THROUGH IT. I KNOW!
3
HOTEL
HELP! POLICE! SUMPIN BUSTED IN THE INJIN ROOM.
4
DAMIT! I TOLD TIGHTWAD THIS IMITATION RAINBOW WAS WORTHLESS. THEY ARE ALL ON THE BUM. I'VE BEEN ON GUARD DAY AND NIGHT AND SUNDAY TOO SINCE USING IT. B-Z-Z-Z-Z
5
6
THE ECLIPSE SECTIONAL RAINBOW GASKET
THE ORIGINAL & ONLY GENUINE SECTIONAL GASKET
CAN BE MADE INSTANTLY WITHOUT WASTE

SOLE MANUFACTURERS OF THE CELE

THE PEERLESS RUBBER

16 WARREN STREET,

5
BRING A SHEET OF PAPER? I'VE LOST MY CLOTHES!
SAVE MY DOG?
HOTEL
FORTY MINUTES FROM BROADWAY. OH, IT'S —!
WOW!
IS MY HAIR ON STRAIGHT?
7
ISN'T IT LOVELY?
OH JOY!
I SAVED MY DOG!
HURRAH!
YOU MEN SHOULD APOLOGIZE TO THE ENGINEER!
WE WILL!
WE WILL!
YOU BET!
HOTEL
MR. TIGHTWAD IS A GOING TO BUY GENUINE RAINBOW PACKING!
6
GENTLEMEN! MR. TIGHTWAD IS AT FAULT HE INSISTS I SHALL USE PUNK FOR PACKING. I AM GOING OUT AND BUY THE GENUINE RAINBOW PACKING, EVEN IF I HAVE TO PAY FOR IT MYSELF. I'M FROM MISSOURI AND I'LL SHOW YOU.
WHY DONT THEY GET AN ENGINEER?
THROW HIM OUT!
I'LL PUT OUT YOUR LAMPS!
I'LL HAVE MY SON TO THRASH YOU!
BERNASCONI BROS. N.Y.
8
GENTLEMEN! THIS IS THE GENUINE RAINBOW PACKING
ITS BULLY GOOD PACKING!
THREE CHEERS FOR THE PACKING THAT NEVER BLOWS OUT!
THE CHIEF KNOWS HIS BUSINESS!
MY SON MUST USE IT IN THE STEEL WORKS
PEERLESS PISTON AND VALVE ROD PACKING GIVES FROM 12 TO 18 MONTH'S PERFECT SERVICE.

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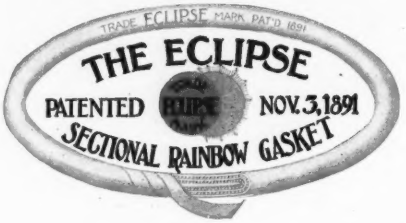

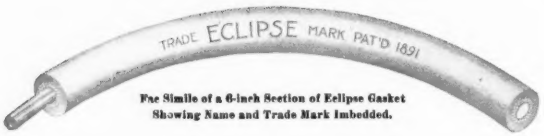

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Showing Name and Trade Mark Imbedded.

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The most economical and convenient form
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Will carry in stock for years.
Absolutely no waste.

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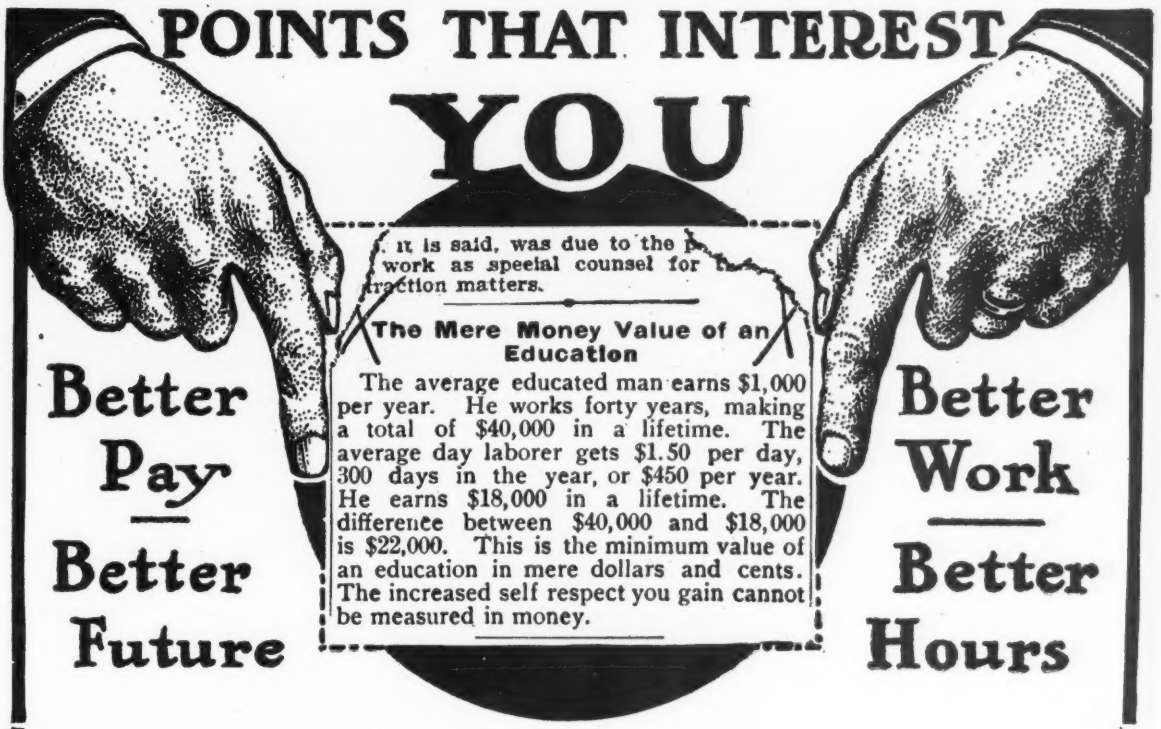
POINTS THAT INTEREST YOU



. it is said, was due to the [illegible] work as special counsel for the [illegible] traction matters.

The Mere Money Value of an Education

The average educated man earns $1,000 per year. He works forty years, making a total of $40,000 in a lifetime. The average day laborer gets $1.50 per day, 300 days in the year, or $450 per year. He earns $18,000 in a lifetime. The difference between $40,000 and $18,000 is $22,000. This is the minimum value of an education in mere dollars and cents. The increased self respect you gain cannot be measured in money.

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Please send me 200-page hand-book. I am interested in the course marked "X."

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to know that the formulas of

WARLEY'S BOILER CLEANSING COMPOUNDS

are founded on sound chemical principles, and that only the purest grades of chemicals obtainable, regardless of cost, are used in the preparation of these goods, which have now been on the market throughout the United States and Canada, and in many other foreign countries as well, for a great many years, and they are now well and favorably known to thousands of Engineers and Steam Users as Boiler Cleansing Compounds that positively remove incrustation or scale and prevent corrosion and pitting in steam boilers, without doing any injury to the boilers, or their fittings, or to any goods in course of manufacture while using the live steam from the boilers with these Compounds in use therein.

These Compounds are varied to suit the individual needs of steam users, and the grade required can be determined when we are furnished with a small piece of scale from the boiler in which the Compound is to be used, a piece weighing about two ounces will be large enough for our purpose.

Send for Blue Book "Questions and Answers for Engineers, etc.," which we will mail to any Engineer, free, who is in charge of a steam boiler, and who will give us the name and address of firm by whom employed and send us a small piece of scale from his boiler, also mention this paper. Address :—

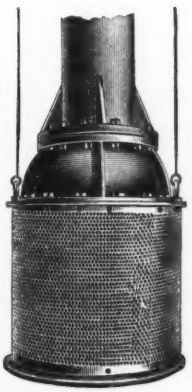
No. 221 South Front Street **THOS. C. WARLEY & CO.** **PHILADELPHIA, PA.**

We also carry a full line of High Grade LUBRICATING OILS and GREASES. A trial order solicited.

The Continuous Service

Foot Valve

Water can be taken continuously and without interruption from streams and ponds that are full of leaves, twigs, fish, sticks, paper and other refuse.



Outer Screen resting on bottom plate

Outer Screen Drawn part way up on suction pipe

NO STOPPAGE FOR CLEANING

The outer screen is raised by ropes or chains for cleaning.

When outer screen is lowered into position the knives at top and bottom scrape the outer surface of the inner screen and clean it.

The suction pipe extends to within a few inches of the bottom plate of valve, thus permitting of successful operation in shallow water.

WRITE FOR PRICES

The

Newman Mfg. Co.

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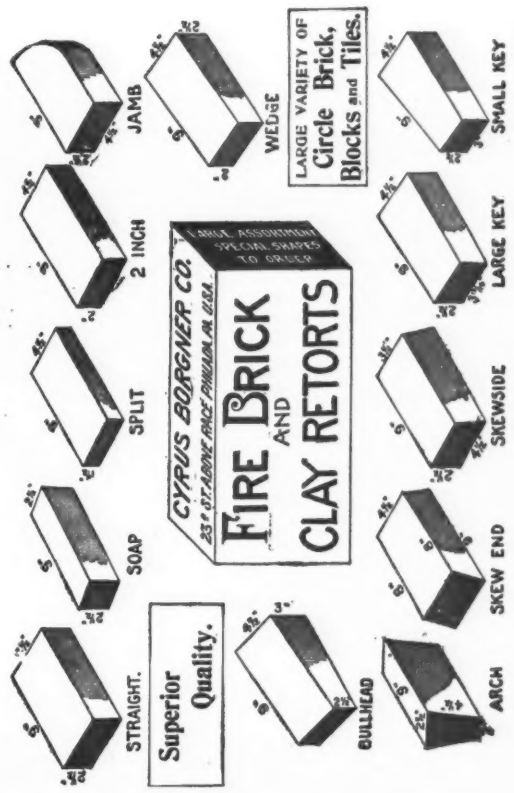


Every Engineer

desires to operate his plant with the utmost practicable economy.

Every Employer

is anxious to keep the expense account just as low as possible.

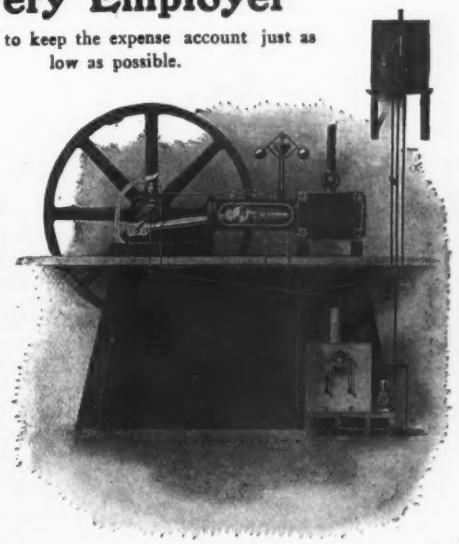
In a power plant where the

White Star Continuous Oiling System

is in use, the saving of oil is astonishing from the start and and becomes fairly astounding as the weekly items pass into the monthly totals, and the monthly totals mount into yearly aggregates showing

REDUCTIONS OF FULLY ONE-HALF

The savings begin with the first minute the system is in operation. We have been collecting facts and figures on the subject which we will be pleased to send, together with booklet "F" which illustrates and describes our method of perfect and economical lubrication of engine bearings. Send for it.



Pittsburgh Gage & Supply Co., Pittsburgh, Penna.

Dixon's Graphite
Lightens YOUR Work

It permits cutting down of oil supply, that's one way.

It makes piston packing wear longer, that's another way.

It renders cutting of bearing surfaces absolutely impossible always

Free Sample, 96-C, awaits your request.

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JERSEY CITY, N. J.

The Best Lubricant
AIR
MICA FLAKE
FLOATED

Use it once and no other lubricant will ever satisfy you Greatest lubricant ever discovered. Try it on the worst bearing you have, or in your cylinder.

SAMPLE FREE
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THE GENUINE
GANDY
PATENTED 1877

GENUINE GANDY

HELPS THE ENGINE DO ITS DUTY

because it grips, not only when the load is steady, but when it's jumping from one extreme to the other

Let us send you our booklet "Experience with Gandy" its worth reading.

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BALTIMORE, MD.

GANDY 6 PLY

GENUINE GANDY

Please Ponder This

There is not in any department of your plant a single mechanical improvement that did not displace what you (or your father or his) once regarded as the "sure enough" best thing out; isn't that so?

"LEVIATHAN BELT"

is precisely such a supplanter for the reason that it saves a lot of money by outlasting two or three rubber belts, working on the same job.

Other people say this of it in a booklet th we'd be glad to mail you. Shall we?

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Red Seal Boiler Compounds

RED SEAL BOILER COMPOUND

have been on the market over 13 years. Its sales are constantly increasing. Why? Because its quality and effectiveness are understood by intelligent engineers.

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if not properly done, in any plant, will cause the engineer a great deallof trouble, and his employer unnecessary expense. Many years of practical experience and a force of competent assistants enables me to guarantee absolute satisfaction.

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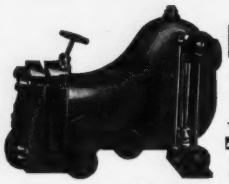
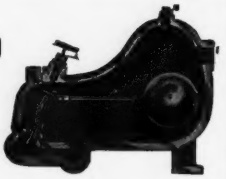
McDANIEL
Improved Steam Trap





All the working parts are connected to the bonnet and are removable with it, making it most convenient to repair.

You never have to break a pipe joint they are all on the body.

We know this Trap will please you. May we send you one for trial.

Reducing Valves, Exhaust Pipe Heads, Ejectors, Relief Valves, Separators, etc.

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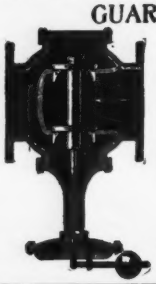
GUARANTEED TO GIVE ENTIRE SATISFACTION



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Steam Traps for all services, Damper Regulators, Back Pressure and Relief Valves, Grease Extractors, Steam Separators, Hot Water Temperature Controllers, Boiler Feeders, Tank Pump Controllers, Float Valves, Water Arches, Waste Heat Utilizers, Pump Regulators, Automatic Receivers and Pump Regulators, Water Feeders, Combination Muffler Tanks, Grease Extractors, etc.

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THE "STERLING" EXHAUST HEAD for separating condensation from Exhaust Steam. Causes absolutely no back pressure. SENT ON TRIAL FREIGHT PREPAID. For sale by contractors and supply houses.

THE "STERLING" VENTILATOR allows free egress of the air and is weather proof. The most durable, and efficient stationary ventilator made.

THE "STERLING" REVOLVING VENTILATOR is efficient, reliable and requires no power or attention, insures a high degree of ventilation.

The Sterling Blower and Pipe Mfg. Co., HARTFORD, CONN. N. Y. OFFICE:— 136 Liberty Street.

5 Per Cent

and more of your total steam is **lost** through leaking joints.

AVOID IT AND USE

GOETZE'S

Elastic Copper Gaskets

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BEST HIGH-GRADE HIGH-PRESSURE PACKING

The toughest, most elastic and most pliable packing made A few turns used in connection with any packing you now have will improve that packing greatly.

Try it and you will always be a friend of Zena.

WRITE TO ME AND ASK ABOUT IT

RANDOLPH BRANDT, 70 Cortlandt St., New York

Feed-Water Regulation Is Essential

to a well ordered plant, and is just as important as fuel regulation. A water line which is fixed, and lived up to, so to speak, means a saving in fuel, in boiler and engine wear and in condensation, because a uniform steam space in the boiler means drier steam.

THE BURROWS
Feed-Water Regulator and Low Water Alarm

guarantees you a steady water level. It never fails to work. It was designed especially for batteries of boilers, one machine to each boiler directly controlling the water supply. The device is strongly, accurately and simply constructed, contains no stuffing box, no packing, no springs to get out of order and require repairs and all internal parts are of brass. It is adaptable alike to high or low pressure boiler plants, and can be installed as easily as an ordinary water column.

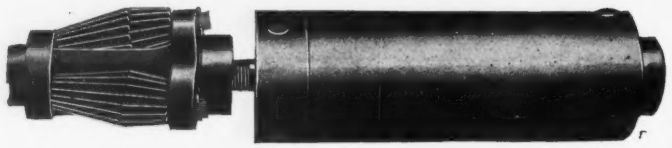
If you are endeavoring to cut down your fuel bills, prevent wear on your equipment and increase the efficiency of your plant generally, you will find your end accomplished when you install a "Burrows." Catalog and free trial offer on request.

Burrows Manufacturing Co.

73 Warren Street New York City

We Certainly Know How To Make Boiler Cleaners

The "DEMON"



IT DEVELOPS OVER 40 TIMES THE POWER OF A TURBINE

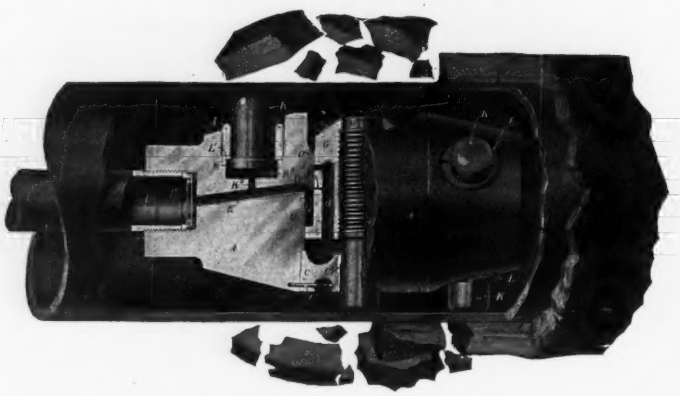
After having engaged for years in the manufacture and sale of other types of water tube cleaners, such as the turbine and the so-called hammer type of machine, we saw a big chance for a superior cleaner and designed the "Demon".

We united all the good and eliminated all the objectionable features of both types. The "Demon" today represents the very highest development in the art. Its tremendous power, its great strength and durability, its absolute safety make it the most ideal water tube cleaner ever used by engineers. TRY ONE AND SEE FOR YOURSELF.

OUR CATALOGUE F TELLS ALL ABOUT IT.

The "TORPEDO"

TAKE A TORPEDO ON FREE TRIAL



IT HAS BUT ONE MOVING PART

Take a look at your fire tube boilers and see how foolish it is to try and keep them clean without a specially designed tool for that purpose.

Do you know that we are willing to refund amount paid for a "Torpedo" if it cannot save at least its cost during the first six months? Do you know of any other appliance you can add to your steam plant that can pay 200 per cent return of the investment? Why not take a "Torpedo" then and watch the scale fly? It will be the most interesting test ever made in your boiler-room.

Send today for our new catalog No. 30 entitled "How to tell a good fire tube cleaner."

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FREE

Our new Catalog—tells how Simply, Effectively and Cheaply

Soft Water

may be obtained—Pictures of the Apparatus, Principal Installations and full details. Firm name on postal.

"A LABORER CAN OPERATE IT."

American Water Softener Co.
1002 Mutual Life Building
PHILADELPHIA, PA.

GET A LAGONDA
BOILER TUBE CUTTER

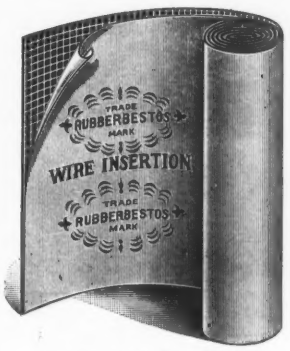
You can't afford to hire a boiler maker or waste time and temper on an inferior, hard-running cutter when your fireman can cut any boiler tube slick and clean in a minute with the Lagonda Cutter. It pays for itself in three usings and is practically indestructible. Don't take our word for it, but send for a sample machine for free trial.

We also make Weinland Mechanical and Turbine Boiler Tube Cleaners, the Lagonda Reseating Machine, the Lagonda Cut-Off Valve and the Lagonda Damper Regulator, and clean boilers by contract. Write for Catalog No. 21.

The Lagonda Mfg. Co. SPRINGFIELD, OHIO

New York Pittsburg Philadelphia Chicago San Francisco

Rubberbestos Sheet Packing

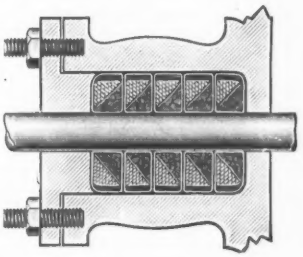


TRADE MARK REGISTERED

Can always be relied on in **difficult** places or in high pressure joints, as it is made of **Rubber** and **Asbestos** and so is perfectly at home under such conditions.

If the flanges are uneven use the metal inserted, or if the pressures are extreme we suggest the **wire** inserted made in three styles to suit all exigencies.

Combination STEAM AND WATER PACKING



is the **Simplest** and **Best.** It is all packing, nothing there but what is needed. The **Rubber** back expands the packing on to the rod and **keeps it tight.** Pure soft flax is next to the rod so there can be no scoring—the wedge forces it when desired by setting up the gland **finger tight only.** Do you want a sample?

ISN'T THIS JUST WHAT YOU NEED?

LOOK FOR THE NAME—

The Genuine is marked thus

This Scraper cleans **both ways going** and **coming.** The brush follows and takes out any fine particles that the scraper might leave, then the tubes are **clean** as when **new.** **Hadn't you better send for one now?**

A. W. CHESTERTON & CO.

No. 64 INDIA STREET BOSTON, MASS.

ADVANCE PACKING & SUPPLY CO.
55 So. Canal Street, Chicago, Ill.

Cash PAID FOR SECOND-HAND BELTING

ALL SIZES BELTING ON HAND

FOR SALE

W. T. SHACKLEY & SONS, (ESTABLISHED 1886) 49 High Street, Boston, Mass.

CORRUGATED COPPER GASKETS

SAVE STEAM and make ABSOLUTELY TIGHT JOINTS

Best and Cheapest—Samples Free.

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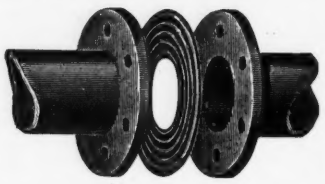

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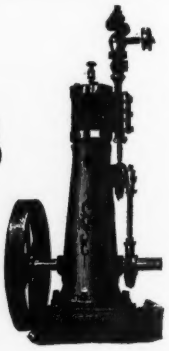

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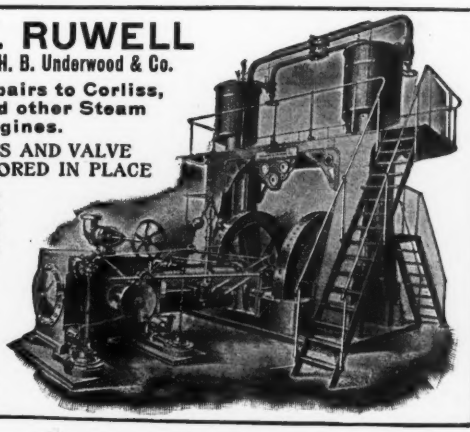

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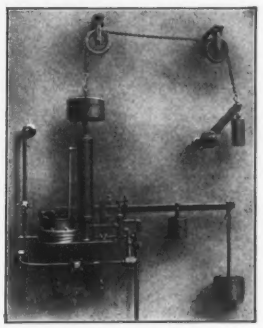

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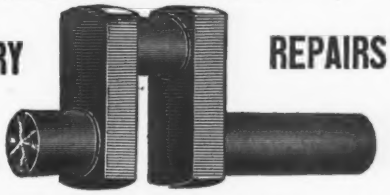

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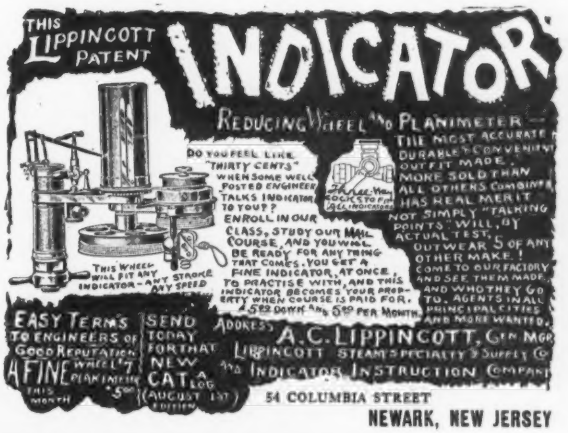
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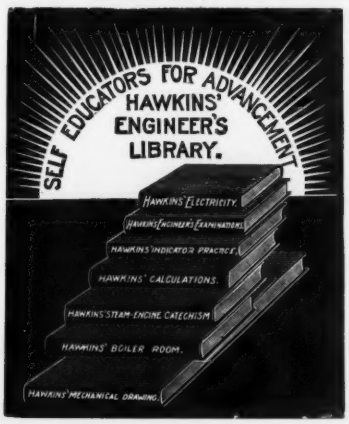

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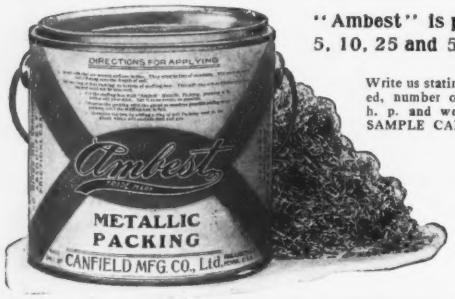

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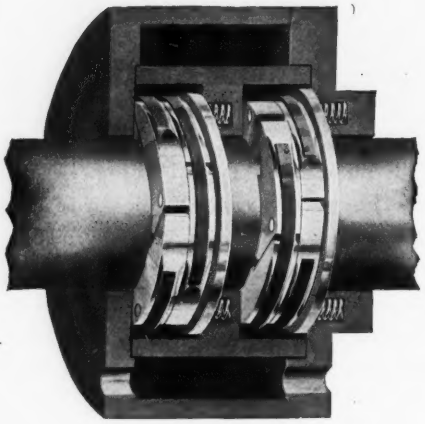

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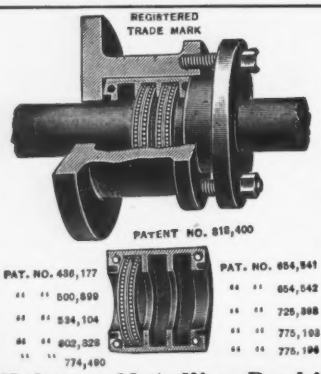

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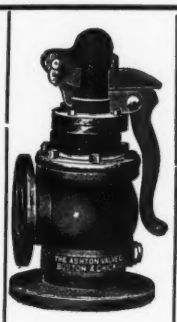

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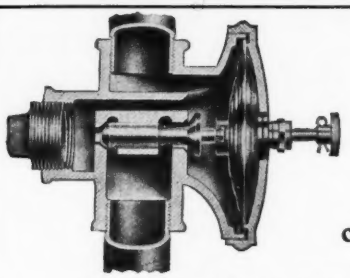

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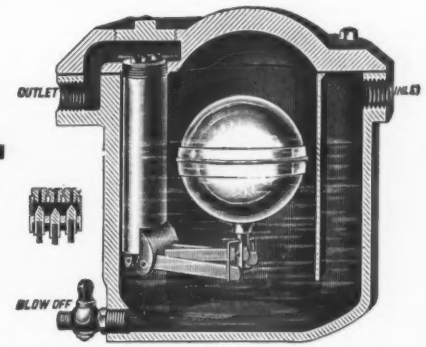

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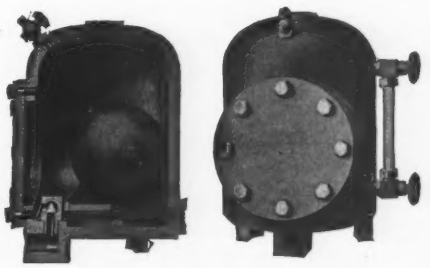

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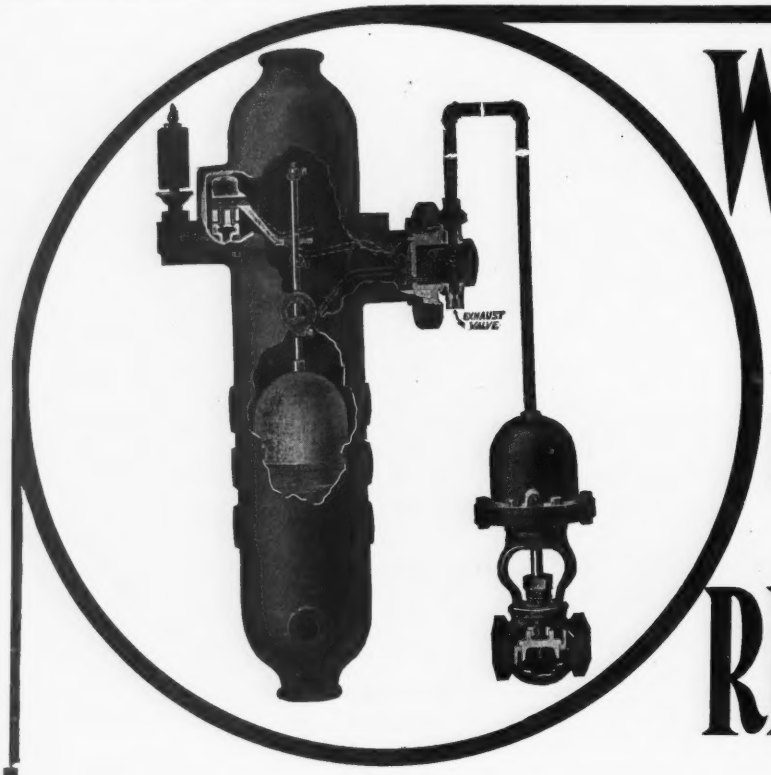

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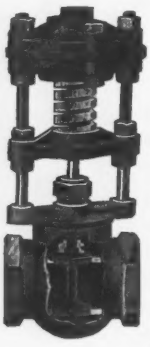

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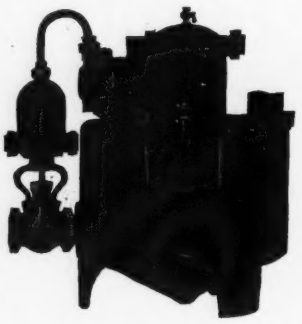

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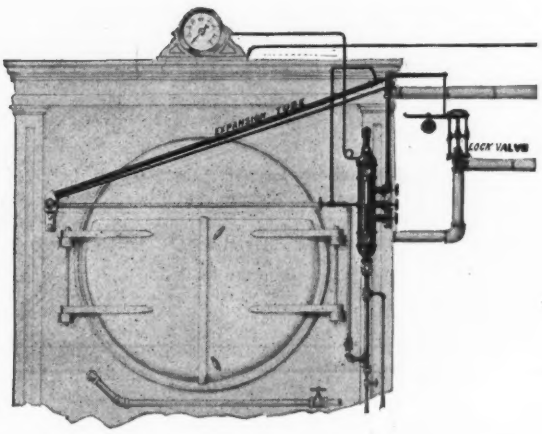

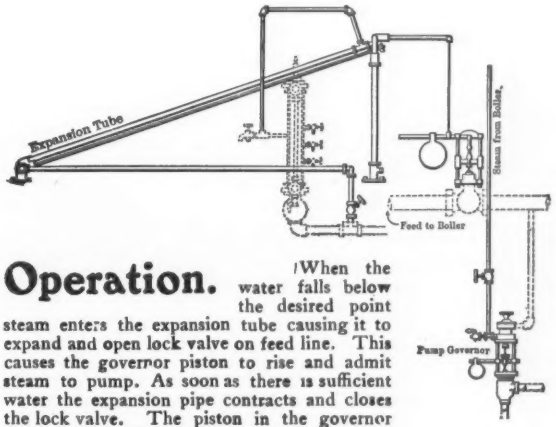

Operation. When the water falls below the desired point steam enters the expansion tube causing it to expand and open lock valve on feed line. This causes the governor piston to rise and admit steam to pump. As soon as there is sufficient water the expansion pipe contracts and closes the lock valve. The piston in the governor moves down, shutting off the steam to the pump. Write for complete description.

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maintains a uniform water level which cannot vary even a quarter of an inch from year's end to year s end. It saves its cost many times over in fuel, saves packing, oil, pump repairs, cutting of engine valves and cylinders—to say nothing of the injurious contraction and expansion of your boilers which it prevents.

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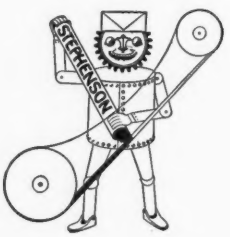

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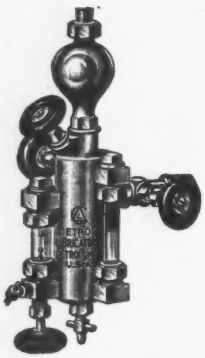

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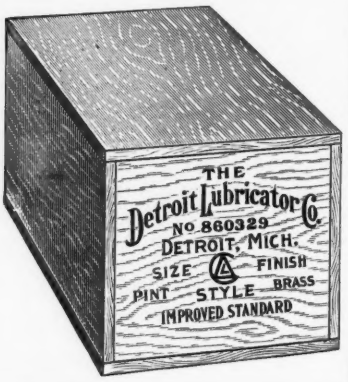

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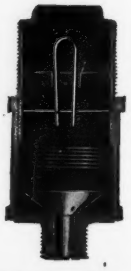

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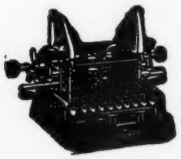

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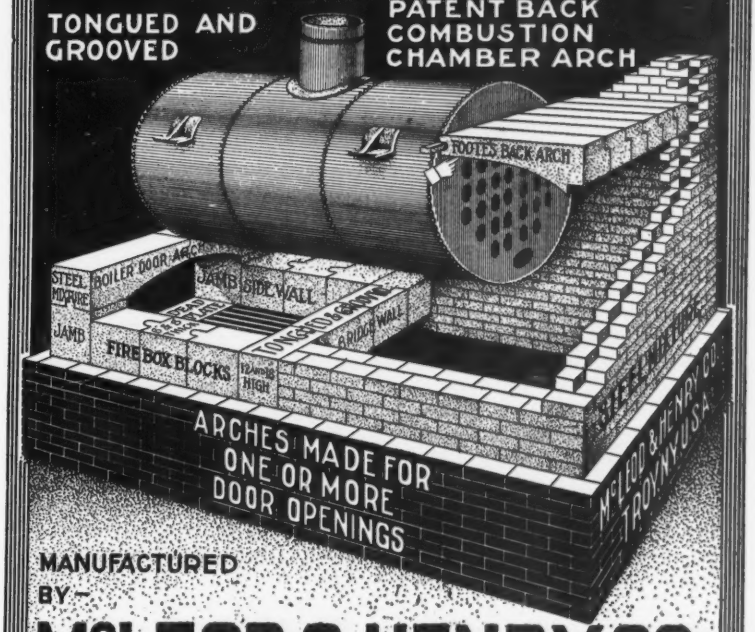

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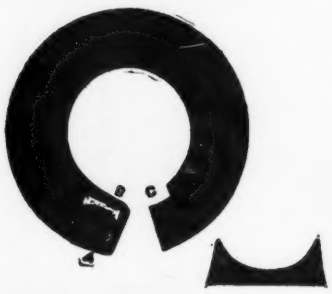

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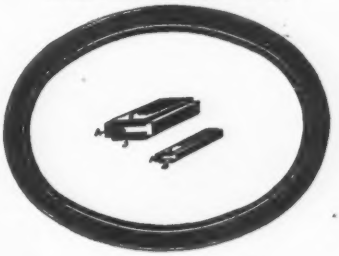

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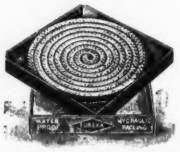
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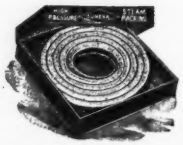
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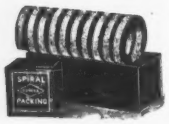

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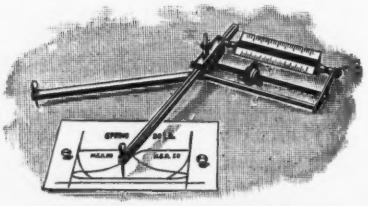
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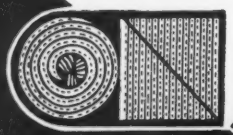

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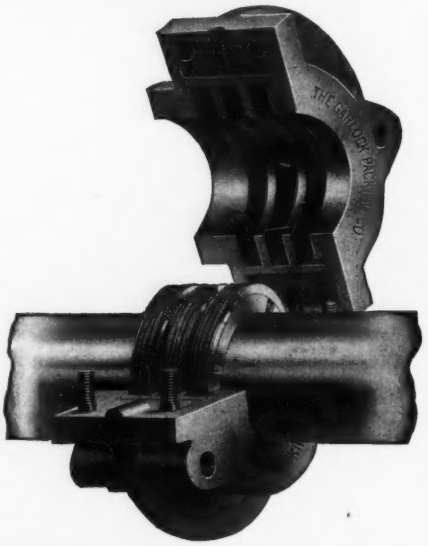

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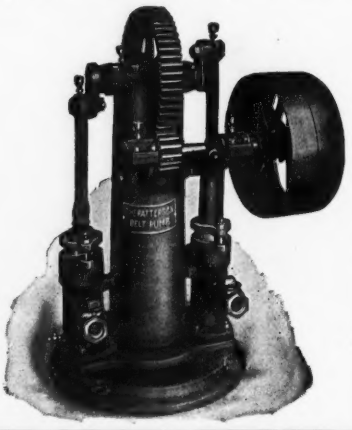

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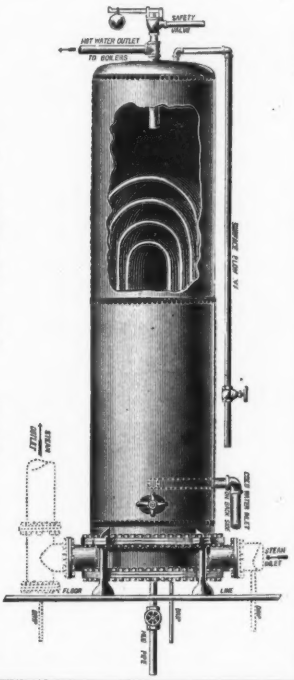

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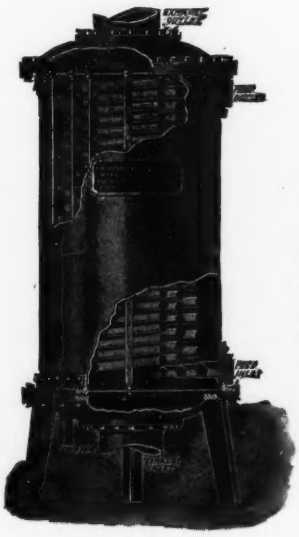

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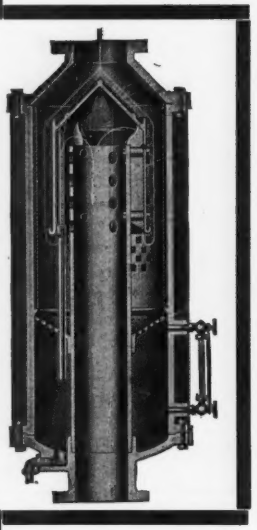

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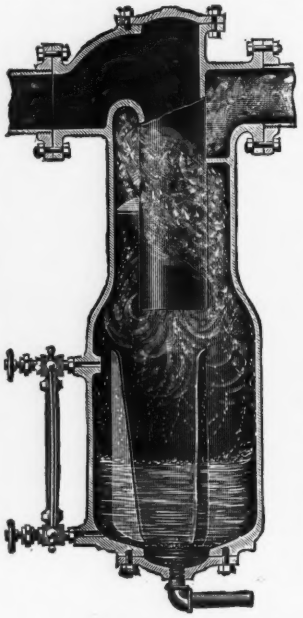
Steam Separator



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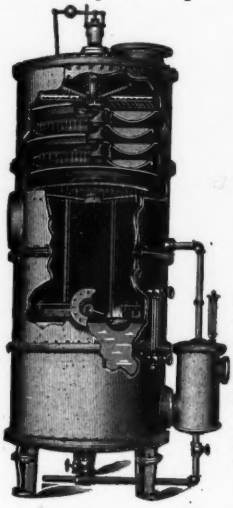

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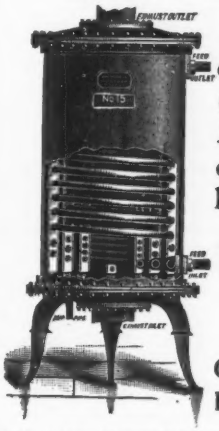

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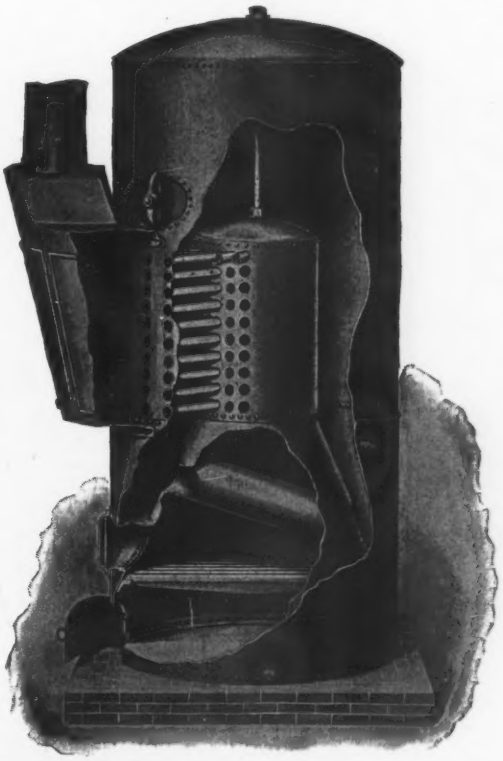

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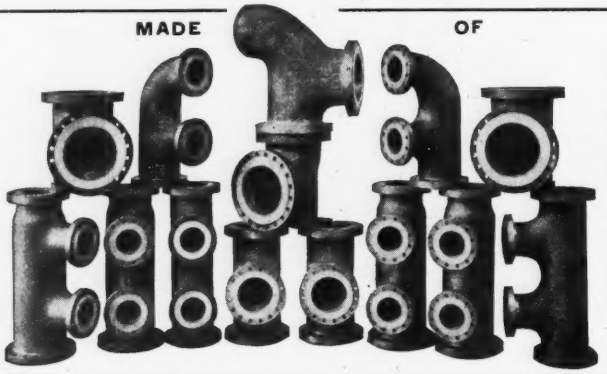

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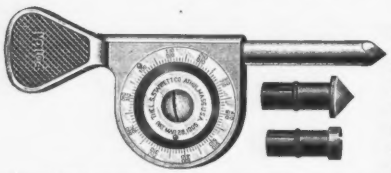

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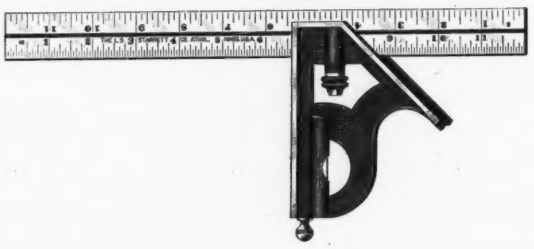

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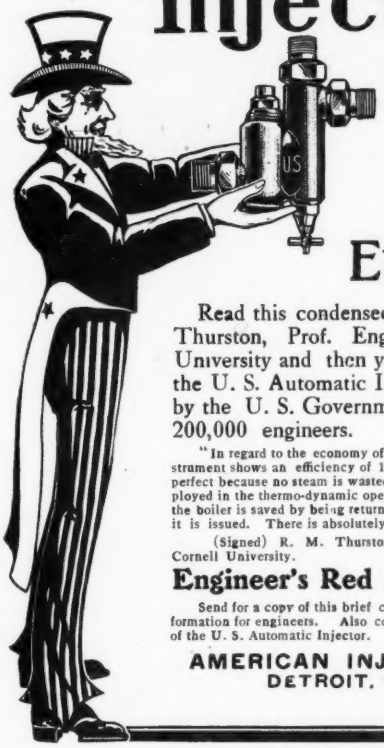

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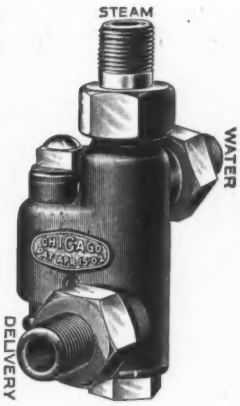

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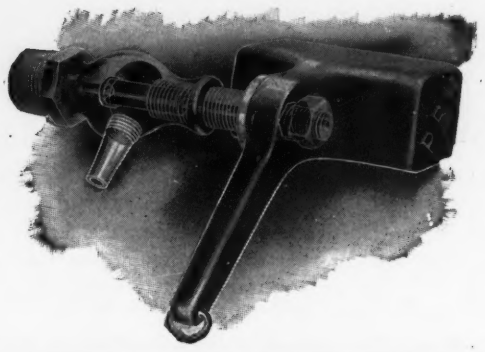

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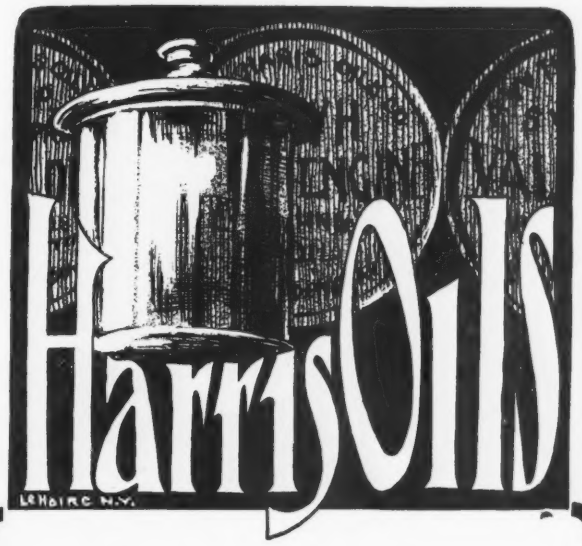

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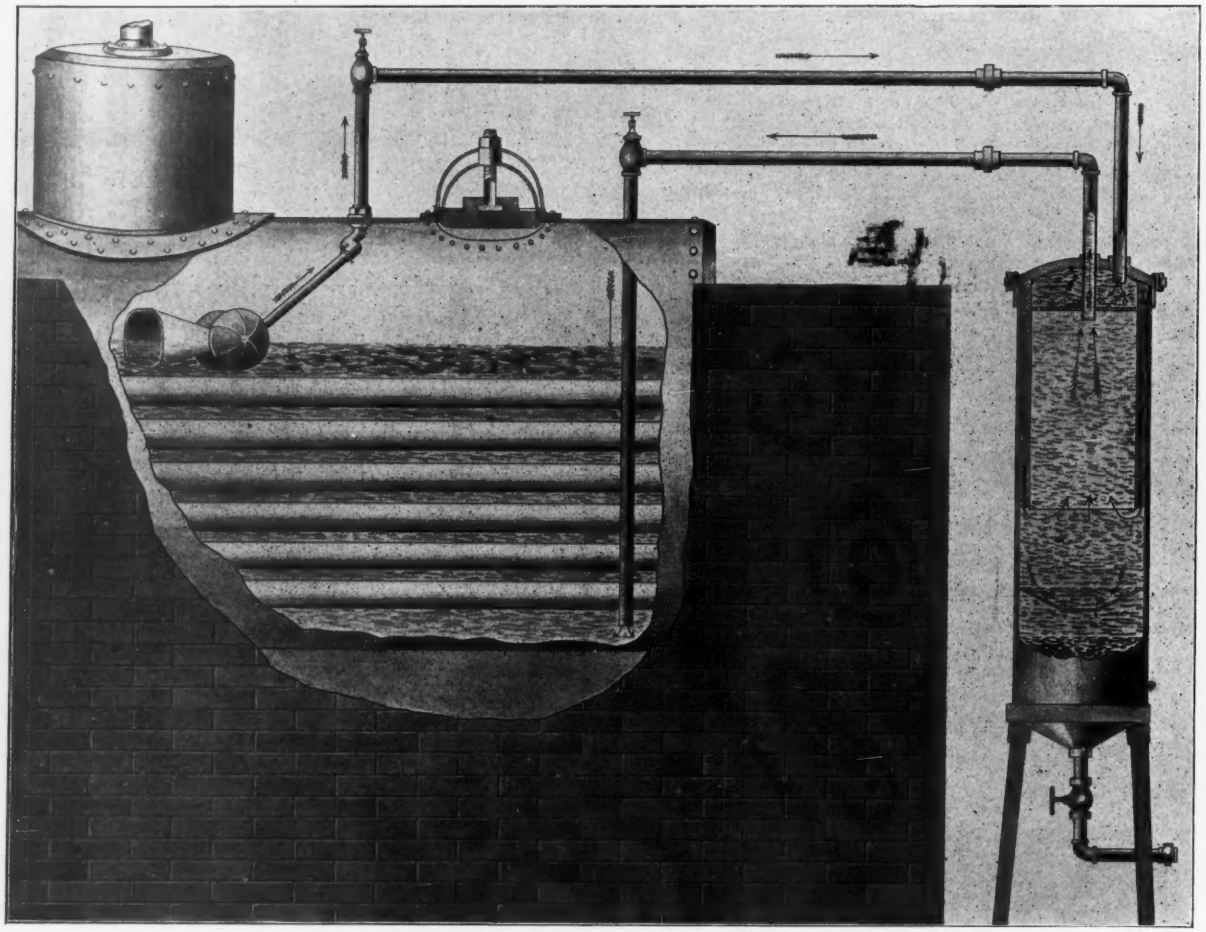

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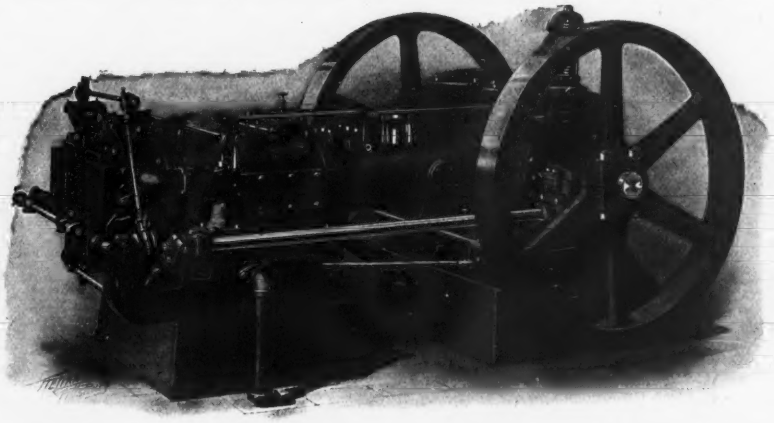

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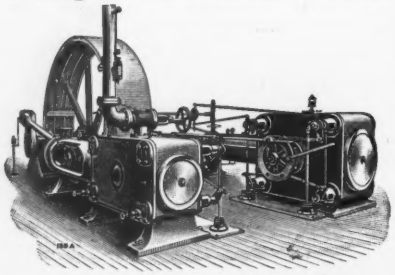

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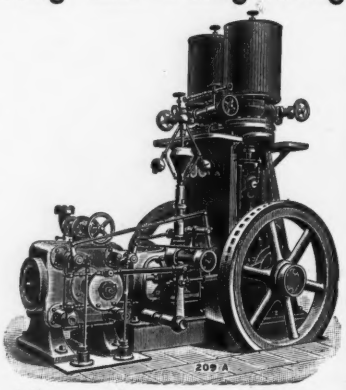

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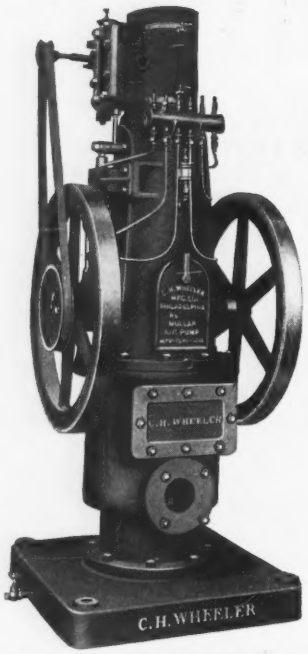

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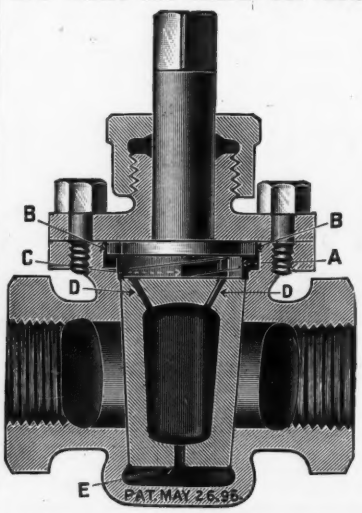

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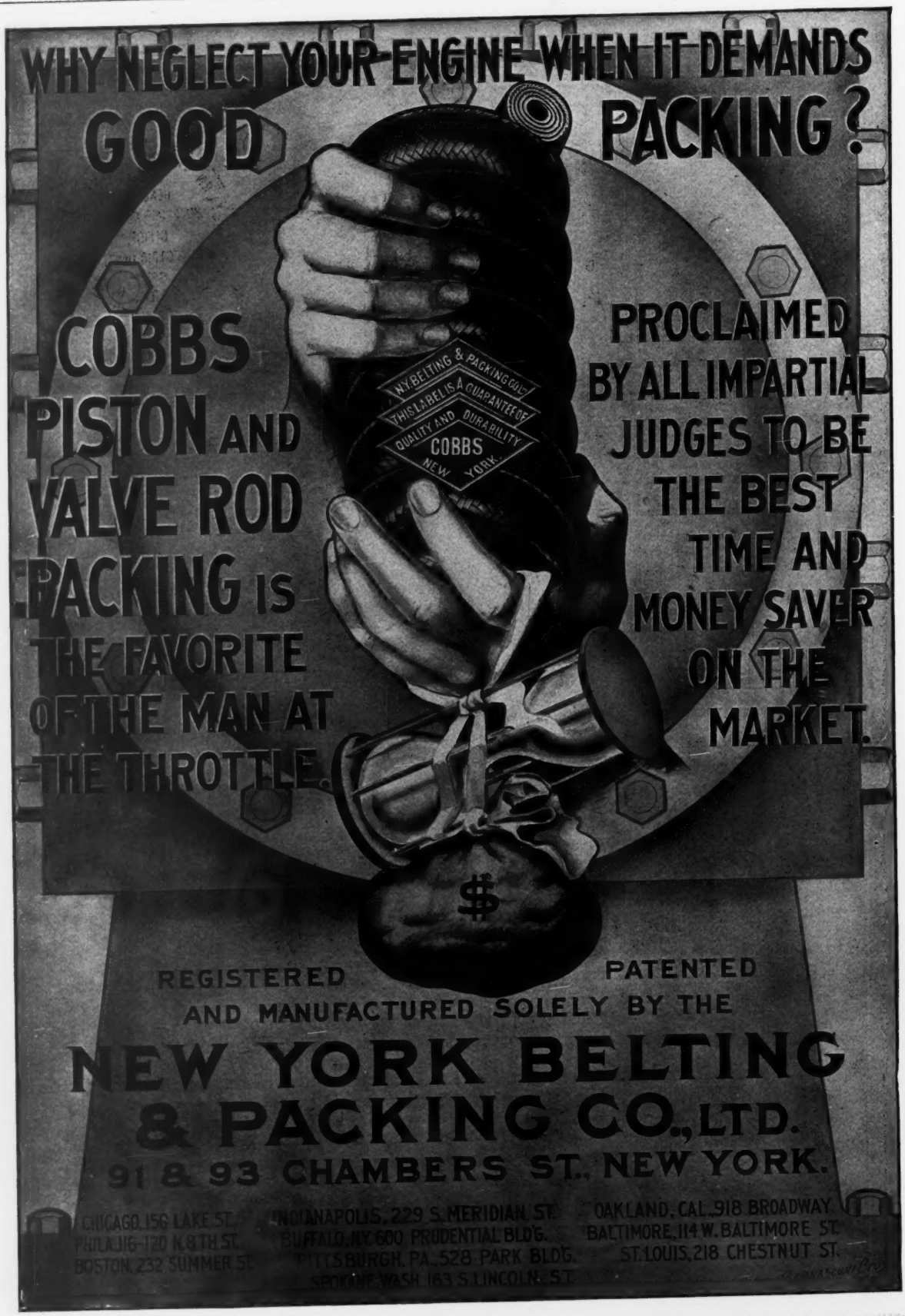
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